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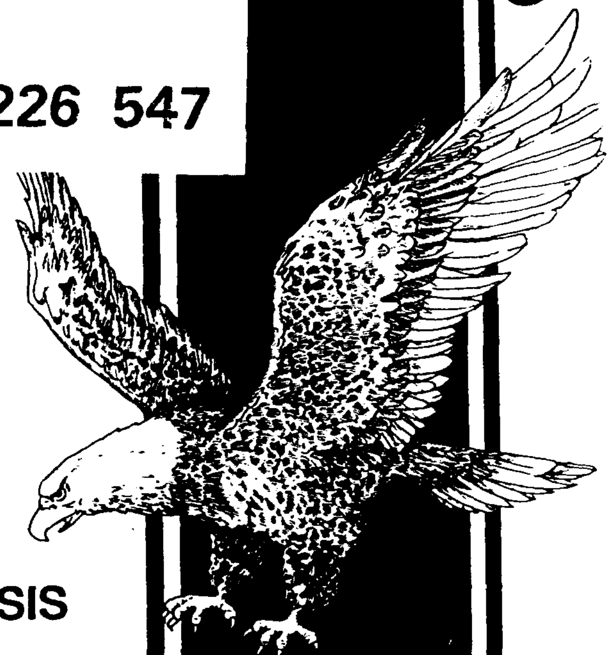

HAZARDOUS WASTE SITE ANALYSIS (SMALL SITE TECHNOLOGY)

Report Number CETHA-TS-CR-90066

August 1990

Prepared for:

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Aberdeen Proving Ground (Edgewood Area),
Maryland 21010-5401

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A methodology is presented for classifying hazardous waste sites according to six primary discriminators, i.e. (1) risk to public, (2) setting of the site, (3) uncontrolled releases, (4) federal laws and regulations, (5) societal and political issues, and (6) estimated cost of remediation. A decision tree is used to ask questions of the user about each waste site to be classifed. Each possible answer to the questions has a numerical weighting factor. At the conclusion of classification, the weighting factors for each site may be totaled so that multiple waste sites may be ranked against each other in a priority listing. The methodology will also recommend possible remediations (treatments) for each waste site, based upon (1) waste constituents, (2) soil permeability, and (3) medium and environment to be treated. The system was tested on five small waste management units at the Sierra Army Depot, Herlong, CA. The methodology can be computerized, if desired.

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HAZARDOUS WASTE SITE ANALYSIS
(SMALL SITE TECHNOLOGY)

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August 1, 1990

ABSTRACT

A methodology is presented for classifying hazardous waste sites according to six primary discriminators, i.e. (1) risk to public, (2) setting of the site, (3) uncontrolled releases, (4) federal laws and regulations, (5) societal and political issues, and (6) estimated cost of remediation. A decision tree is used to ask questions of the user about each waste site to be classified. Each possible answer to the questions has a numerical weighting factor. At the conclusion of classification, the weighting factors for each site may be totaled so that multiple waste sites may be ranked against each other in a priority listing. The methodology will also recommend possible remediations (treatments) for each waste site, based upon (1) waste constituents, (2) soil permeability, and (3) medium and environment to be treated. The system was tested on five small waste management units at the Sierra Army Depot, Herlong, CA. The methodology can be computerized, if desired.

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TABLE OF CONTENTS

DEFINITIONS (ACRONYMS)

ARAR - Applicable or Relevant and Appropriate Requirement
CAA - Clean Air Act
CEQ - Council on Environmental Quality
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act of 1980, a.k.a. Superfund.
CFR - Codified Federal Regulations
CR/CAP - Contribution Rights/Contribution Action Protection
CWA - Clean Water Act
CZMA - Coastal Zone Management Act
DoD - Department of Defense
DOE - Department of Energy
DOI - Department of Interior
DOT - Department of Transportation
DWPA - Deep Water Port Act
EA - Environmental Assessment
ER - Environmental Restoration or Environmental Remediation
EIS - Environmental Impact Statement
EPA - Environmental Protection Agency
FIFRA - Federal Insecticide, Fungicide, and Rodenticide Act
HMTA - Hazardous Materials Transportation Act
HSRT - Hazardous Substance Response Trust (Superfund Trust)
HSWA - Hazardous and Solid Waste Amendments (to RCRA)
NAAQSD - National Ambient Air Quality Standards
NAQ - National Air Quality
NBAR - Nonbinding Preliminary Allocations of Responsibility
NCA - Noise Control Act
NCP - National Contingency Plan
NEPA - National Environmental Policy Act
NES - National Emission Standards
NESHAP - National Emission Standards for Hazardous Air Pollutants
NPL - National Priority List
NRC - Nuclear Regulatory Commission
NSPS - New Source Performance Standards
NWPA - Nuclear Waste Policy Act
OSHA - Occupational Safety and Health Act
PCB - Polychlorinated Biphenyl
PRP - Potentially Responsible Party
PSD - Prevention of Significant Deterioration
QCW - Quality Criteria for Water

RCRA - Resource Conservation and Recovery Act
RD/RA - Remedial Design/Remedial Action
RI/FS - Remedial Investigation/Feasibility Study
ROD - Record of Decision
RWPA - Radioactive Waste Policy Act
SARA - Superfund Amendments and Reauthorization Act (to CERCLA)
SCAP - Superfund Comprehensive Accomplishment Plan
SDWA - Safe Drinking Water Act
SIAD - Sierra Army Depot
SWMU - Small Waste Management Unit
SIP - State Implementation Plan
TSCA - Toxic Substances Control Act
TSDF - Treatment, Storage, and Disposal Facility
UGT - Underground Tanks
UST - Underground Storage Tanks
WQA - Water Quality Act

HAZARDOUS WASTE SITE ANALYSIS
"Small" Site Classifier

Introduction

In mid-1989, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) approached Los Alamos National Laboratory about the possibility of developing a methodology to discriminate between the Army's "small" hazardous waste sites and "large" hazardous waste sites. The reason for developing such a methodology is to assure that seemingly "small" sites are given the appropriate remediation priority and to assure that treatment techniques and technologies developed for large, well-publicized hazardous waste sites (those that are undergoing the earliest remedial actions) would transfer to the "small" sites in an expeditious manner.

The term "small" is used with quotations throughout because it involves more than just physical size. For purposes of this work, the term "small" is defined by the discriminators used to classify the hazardous waste site. The actual size of a site may be so significant as to bear on the ultimate classification, but it is only one of several discriminating factors.

Objectives

The primary objective of this work was to develop a methodology by which "small" waste sites could be discriminated from "large" sites. A decision tree-type of approach was selected due to its relative simplicity and because it has considerable flexibility and can be easily expanded as the methodology evolves. It also has the advantage of being easily adapted to and incorporated into a user-friendly or possibly even "intelligent" computer-based system, should that be desirable at some future time.

In addition to the primary objective, there were two secondary objectives of this work: 1) to develop a method to easily identify the federal regulations that will apply to the "small" sites; and, 2) to develop a means to screen for potentially applicable treatment technologies. There are a myriad of regulations that the federal government has promulgated over the years to address environmental issues and, consequently, there will normally be multiple regulatory "drivers" that will apply to any given hazardous waste site ("large" and "small"). Early identification of the applicable regulations is an important step in planning for eventual site remediation. Likewise, there are a great many treatment technologies that can be considered with respect to applicability, effectiveness, and cost. An easy to use method to screen the candidate treatment technologies is therefore a useful tool in planning the approach for site remediation. These secondary objectives have been developed using decision tree-type analyses to the extent practicable so that they too could be incorporated into a computer-based analysis system at some future time.

Approach

The first step in developing the methodology to classify "small" hazardous waste sites was to define what discriminators should be used, or to establish a definition for "small" sites. USATHAMA had initially identified the following factors as being important to the classification process: physical environment, human risk, regulations, societal acceptance, and economics. These factors thus become the key elements for incorporation into the definition of a "small" hazardous waste site. To use these factors as functional discriminators they were given equal weights (i.e., too much of any one could, by itself, eliminate a candidate site from further consideration as a "small" site).

The primary discriminators were then broken down into one or more important subelements that in turn were assigned weighting factors to reflect their relative

significance (see Appendix A - Table of Weighting Factors for Figure A-1). It should be noted that the weighting factors used are arbitrary, based on the judgement of the investigators. They can be changed should a user decide that different weights would enhance the classification process. However, if changes are deemed worthy they should be made using a consensus approach by knowledgeable people, and they must be made before any site is evaluated (i.e., if weighting factors are changed after sites have been evaluated, these sites should be reevaluated). Otherwise, the methodology will fail in its intended purpose of providing a uniform means to identify sites that are "small," and to indicate the relative significance of those sites that fall within the "small" site classification.

The methodology for classifying the "small" hazardous waste sites involves the use of 1) a decision tree and 2) supporting information that is needed to accomplish the decision making process. The decision tree methodology is designed to interrogate the user following a systematic pattern that should identify a site that is not "small" at the earliest possible time in the process. If the accumulated weight of the subfactors for any primary discriminator equals or exceeds 20 points, the candidate site being evaluated is eliminated from the "small" waste site category. A candidate site that passes through all of the decision steps without having any of the primary discriminator weights total 20 points or more is classified as a "small" site. All sites ("small" or not "small") are then screened for potential remediation technologies.

Use of the Methodology

To use this system, every multiple choice question must be answered until it is determined that the site is either a "small" site or not a "small" site. Therefore, if the needed information about a site is not immediately available, it must be obtained before the

analysis can be completed. For instance, if a candidate waste site overlies a shallow aquifer that is used locally for crop irrigation, that information is vital to the question (primary discriminator) of imminent risk to the public. An effort was made to minimize the number of questions that require expensive or time-consuming information (i.e., the kind of information that would be obtained as part of a detailed site characterization study), because most "small" site candidates are not expected to have undergone a thorough site characterization before being classified.

It is recommended that the decision tree method of site classification be undertaken by several knowledgeable people for each candidate site. This approach will tend to equalize biases that each person may have due to their particular fields of knowledge about a site or from other causes. If multiple classifiers are used, then scores can be averaged (if all conclude that the given site is "small"), or a majority rule can be applied (if some classify a site as "small" while others do not). In either case, the result is likely to be more credible than if only one person does the analysis. A second recommendation is that the weighting factors for each subelement not be given to the classifiers in advance. The classifier(s) should select the most appropriate answer for each multiple choice question without knowledge of how "weighty" a particular answer will be relative to the others. This too will tend to reduce any bias that the classifier(s) might bring to the process. If this approach is used, the answers will be "graded" (i.e., the weighting factors assigned and summed) after the classifiers complete their selections of the most appropriate answers for the given site. Although both of these recommendations are optional, it is likely that they will enhance the overall credibility of the classification process if used.

In the following section each of the classification questions from the decision tree (see Appendix A -- Fig. A-1 and Table of Weighting Factors for Figure A-1) will be discussed. It is

very important to recognize the iterative nature of the classification process – that is, the first time it is used, the user is not expected to have a great amount of site or waste characterization information, but the second time through, after site characterization has been completed, the user will be in a position to "fine tune" the initial results. If a preliminary site characterization study is made (as sometimes happens) it may be desirable to make a second pass after the preliminary study, and then a third pass after the detailed site characterization is completed.

Discussion of Weighting Factors

Determine if Site Poses Imminent Health Risk to Public

A1. Do waste constituents in soil contain sufficient quantities of toxic organics or heavy metals to be a health risk?

Discussion: For the initial screening, use the best available information. On subsequent iterations (after site characterization), however, the accuracy of your answer will improve. "Very High Concentrations" means that measured levels far exceed soil limit(s) found in Appendix B of the Defense Priority Model (DPM) for the contaminant(s) in question. "Moderately high concentrations" means that measured levels are near (either above or below) DPM soil limit(s) for the contaminant(s) in question. "Low concentrations" means that measured levels are well below the DPM soil limit(s) for the contaminant(s) in question. This ranking method is without regard to how the contaminant(s) got into the soil.

A2. Do waste constituents in ground water contain sufficient quantities of toxic organics or heavy metals to be a health risk?

Discussion: For the initial screening, use the best available information. On subsequent iterations (after site characterization), however, the accuracy of your

answer will improve. "Very high concentrations" means that measured levels far exceed DPM ground water limit(s) for the contaminant(s) in question. "Moderately high concentrations" means that measured levels are near (either above or below) DPM ground water limit(s) for the contaminant(s) in question. "Low concentrations" means that measured levels are well below the DPM ground water limit(s) for the contaminant(s) in question. This ranking method is without regard to how the contaminant(s) got into the ground water.

A3. Do waste constituents in surface water contain sufficient quantities of toxic organics or heavy metals to be a health risk?

Discussion: For the initial screening, use the best available information. On subsequent iterations (after site characterization), however, the accuracy of your answer will improve. "Very high concentrations" means that measured levels far exceed DPM surface water limit(s) for the contaminant(s) in question. "Moderately high concentrations" means that measured levels are near (either above or below) DPM surface water limit(s) for the contaminant(s) in question. "Low concentrations" means that measured levels are well below the DPM surface water limit(s) for the contaminant(s) in question. This ranking method is without regard to how the contaminant(s) got into the surface water.

A4. Do waste constituents in air contain sufficient quantities of toxic organics or heavy metals to be a health risk?

Discussion: For the initial screening, use the best available information. On subsequent iterations (after site characterization), however, the accuracy of your answer will improve. "Very high concentrations" means that measured levels far exceed DPM air limit(s) for the contaminant(s) in question. "Moderately high

concentrations" means that measured levels are near (either above or below) DPM air limit(s) for the contaminant(s) in question. "Low concentrations" means that measured levels are well below the DPM air limit(s) for the contaminant(s) in question. This ranking method is without regard to how the contaminant(s) got into the air.

Determine the Physical Setting of the Site

B1. Is site in close proximity to ground water supplies that are used for domestic or agricultural purposes?

Discussion: For the initial screening, use the best available information on depth to standing water from the surface. For subsequent screenings (after site characterization), use the vertical distance from the bottom of the waste or contaminated zone to the water table. The bottom of the waste or contaminated zone is determined by site characterization, e.g., core drilling results. In determining the ranking, based on proximity to groundwater, consideration should be given to drought, heavier-than-usual annual rainfall, and possible drawdown of the water table by pumping. If waste has already been detected in the ground water, the weighting factor is automatically equal to 15. If the ground water is naturally non-potable, reduce the weighting factor by one-half.

B2. Is site in close proximity to surface water supplies that are used for domestic or agricultural purposes?

Discussion: For the initial screening, use the best available information. On subsequent iterations (after site characterization), however, the accuracy of your answer will improve. "Surface water" includes fresh water streams, lakes, ponds, reservoirs, ditches, canals, etc. The distance involved is the shortest distance between the waste location and body of surface water, measured along the most likely drainage

course. If waste has already been detected in the surface water body, the weighting factor is automatically equal to 15. If the surface water is naturally non-potable, reduce the weighting factor by one-half.

B3. Is waste in a secure containment(s)?

Discussion: "Uncontrolled" means that the waste or contaminated zone is exposed and no runoff diversion system exists for ground water, surface water, or air emissions (VOCS or fugative dust). "Lined/diked pit, trench, or pad" means the waste or contaminated zone is surrounded by a containment structure that is in sound condition and adequate to contain any runoff, spills, or leaks. "In sealed containers" assumes that the containers are in acceptable condition and not leaking. If the containers are leaking, choose one of the other two options.

B4. Is access to site controlled?

Discussion: "Uncontrolled" means the site has no fences, barriers, or warning signs and is readily accessible by humans or livestock. "Limited area with fence" means the site has either fences or barriers (e.g., walls of a building) and warning signs are clearly posted. "Fenced and guarded" means that the site is securely isolated and subject to regular inspection.

Determine if Site is Subject to Rapid, Uncontrolled Releases to Biosphere

C1. Are waste forms combustible?

Discussion: The weighting factors are for unburied or shallow-buried (up to 1 ft) waste forms. Waste that is buried under more than 1.0 ft of soil can usually be considered "noncombustible".

C2. Is waste site subject to flooding?

Discussion: This includes flooding (1) by runoff from unusually high local precipitation or (2) by overflowing of rivers, canals, lakes, reservoirs, or the ocean surf.

C3. Is waste subject to wind/weather damage or dispersal (tornadoes, hurricanes, wind storms, lightning, etc.)?

Discussion: Judgement should be based on the historic climatological records for the local area. Buried waste (under a minimum of 1 ft of soil) can usually be considered as "low probability".

C4. Is waste site subject to other natural/manmade disasters or disturbances that could damage or disperse waste forms (earthquakes, forest fires, artillery impacts, etc.)?

Discussion: Judgement should be based on historical records of natural events in the local area and current land use for manmade disturbances.

Select Applicable Federal Laws and Regulations That Must be Complied With (see Appendix B)

D1. Do federal regulations require early or immediate remedial action?

Discussion: Sites with ongoing, uncontrolled leakage of hazardous or toxic substances will normally be candidates for immediate interim action. It is recommended that appropriate state and/or federal authorities be consulted if there is <u>any question</u> about the need for early interim measures.

D2. Can site be permanently closed without remediation?

Discussion: A "site" that has been used temporarily (less than 90 days) to store waste containers that are securely sealed, labeled, and protected from the elements <u>might</u> qualify for a "no" answer, provided there is no leakage and continued use of the site as a waste storage facility is not planned. Other sites (after site characterization) may be

deemed to be "non-sites" because they are in compliance with the applicable environmental regulations.

Determine if Site is a Major Societal or Political Issue

E1. Are there any major local (or regional) societal or political issues?

Discussion: This may be judged by the amount and tone of newspaper, radio, and television coverage. Consideration should be given to size and number of public meetings and public demonstrations, if any. Consideration should also be given to the amount of attention given to the issues by city, county, and state officials.

E2. Is there likelihood of societal or political issues before scheduled remediation?

Discussion: Note that the time between identification of a site that must be remediated and the available funds to do so may be from months to decades. If there is any controversy about the site in question or other environmental problems at the facility, there may be reason to expect that the site will become a social or political issue in time.

Determine the Estimated Costs to Remediate Site

F1. What is estimated cost of site characterization?

Discussion: On the first iteration through the logic (i.e., before a detailed site characterization has been done), this answer will be quite rough. It will probably be based upon historical records and previous site characterization costs incurred at comparable waste sites. On subsequent iterations, however, the accuracy of this estimate will improve. For most sites, RCRA Facility Investigation (RFI) or CERCLA Remedial Investigation/Feasibility Study (RI/FS) guidance will provide an understanding of the site characterization requirements.

F2. What is estimated cost of waste treatment?

Discussion: On the first iteration through the logic (i.e., before a site treatment has been selected), this answer will be quite rough. On subsequent iterations, however, the accuracy of this estimate will improve. In addition to treatment costs, this estimate should include the costs for excavation, sorting, packaging, transportation, and disposal of residual waste. Refer to the treatment selection methodology and descriptions in Appendix C.

F3. What is estimated cost of site closure & monitoring?

Discussion: On the first iteration through the logic (i.e., before a detailed site characterization has been done and also before a site treatment has been selected), this answer will be quite rough. On subsequent iterations, however, the accuracy of this estimate will improve. To estimate the cost of site monitoring, it will naturally be necessary to assume a length of time required for the monitoring. This requires a detailed knowledge of the contaminants present (even after treatment is completed). For radioactive contaminants, it will be necessary to know their decay times to acceptable levels. Selection of an appropriate closure and monitoring program will normally be done in conjunction with the state or federal regulating agencies, thus detailed cost estimates will usually not be available until after the closure and monitoring plan is approved.

APPENDIX A

DECISION TREE

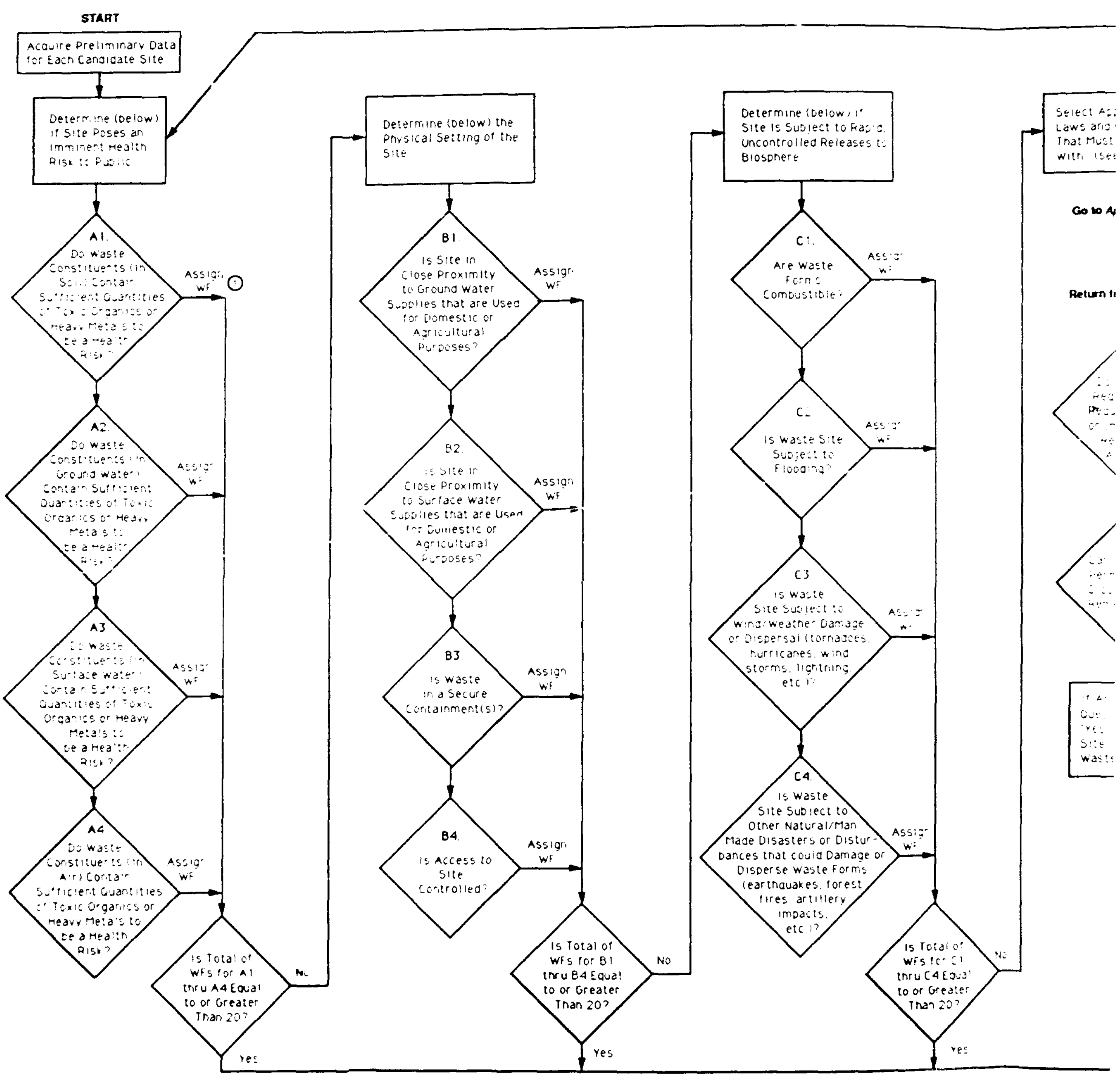
FOR

CLASSIFYING WASTE SITES

AND

TABLE OF WEIGHTING FACTORS

Site



① See Questions in *Appendix A* for Weighting Factors (WFs).

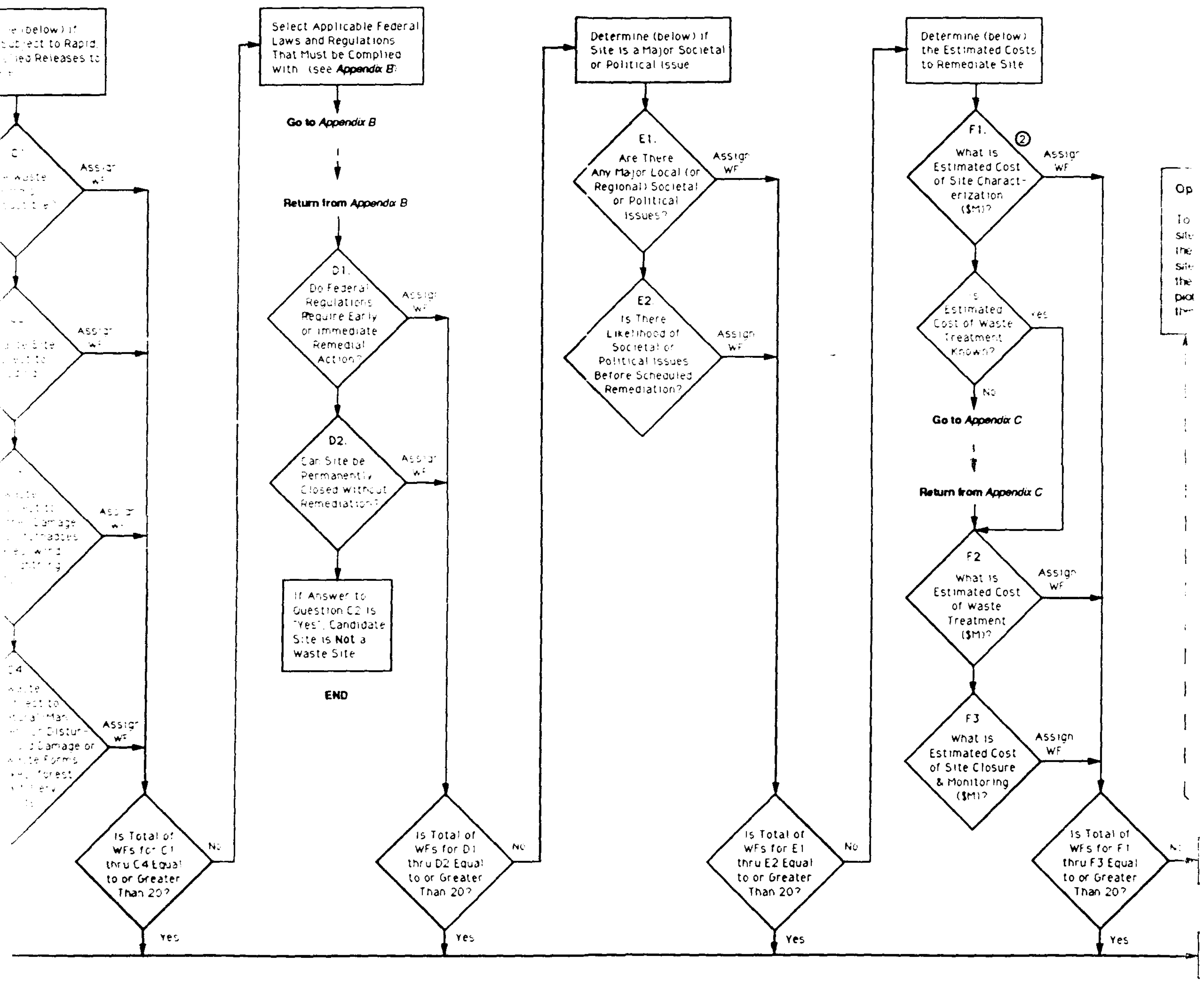
② RI/FS = Remedial Investigation / Feasibility Study

③ ROD = Record of Decision

④ RD/RA = Remedial Design / Remedial Action

NOTE: Names in *italics* are from the other supporting documents.

Site Classifier



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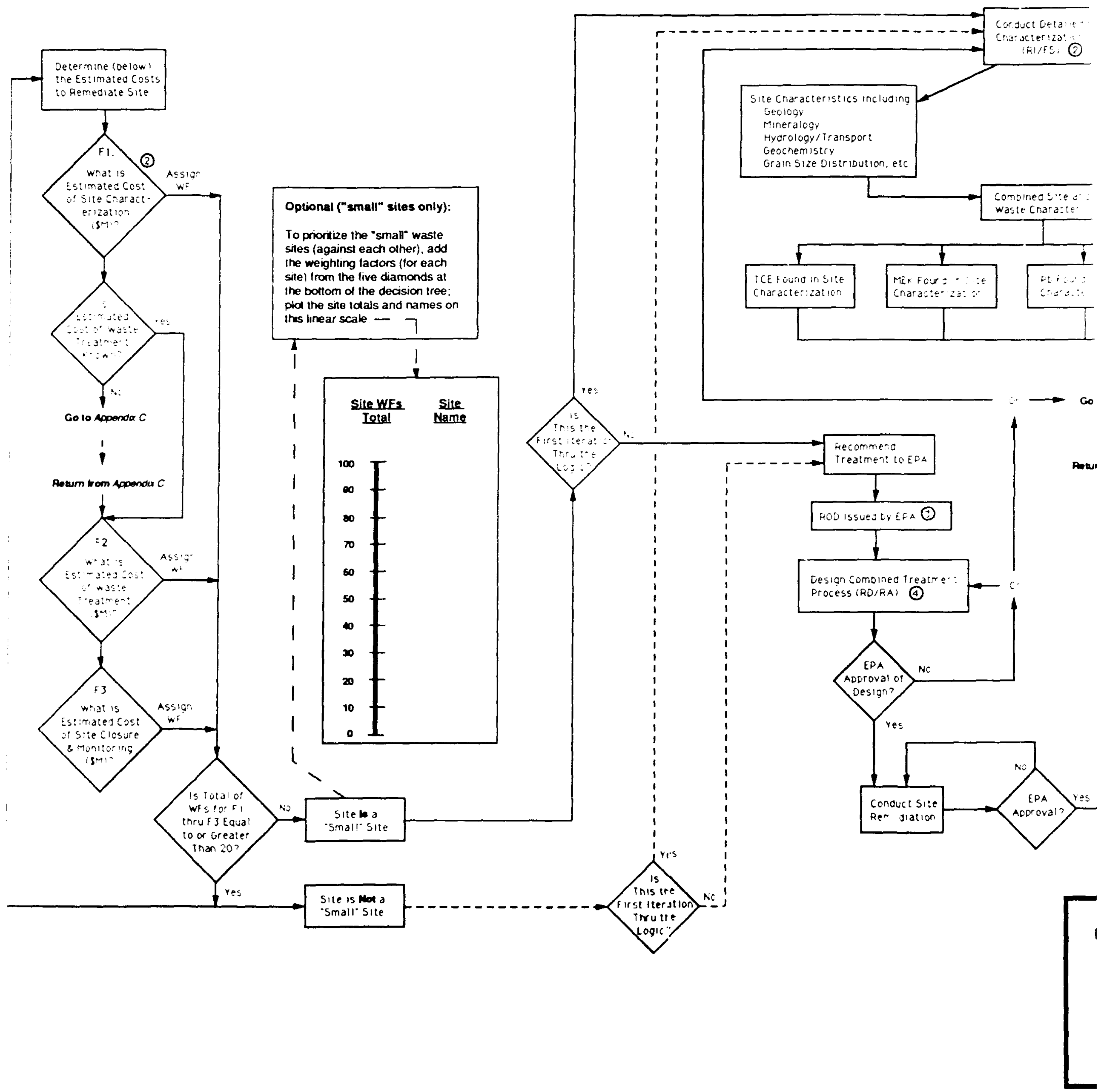


Determine (below) the Estimated Costs to Remediate Site
F1. What is Estimated Cost of Site Characterization ($M)?
Assign WF
Estimated Cost of Waste Treatment Known?
Yes
No
Go to Appendix C
Return from Appendix C
F2 What is Estimated Cost of Waste Treatment ($M)?
Assign WF
F3 What is Estimated Cost of Site Closure & Monitoring ($M)?
Assign WF
Is Total of WFs for F1 thru F3 Equal to or Greater Than 20?
No
Yes
Site is a "Small" Site
Site is Not a "Small" Site
Optional ("small" sites only):
To prioritize the "small" waste sites (against each other), add the weighting factors (for each site) from the five diamonds at the bottom of the decision tree; plot the site totals and names on this linear scale
Site WFs Total
Site Name
100
90
80
70
60
50
40
30
20
10
0
Yes
No
Is This the First Iteration Thru the Logic?
Recommend Treatment to EPA
ROD Issued by EPA
Design Combined Treatment Process (RD/RA)
EPA Approval of Design?
No
Yes
Conduct Site Remediation
EPA Approval?
No
Yes
Site Characteristics Including
Geology
Mineralogy
Hydrology/Transport
Geochemistry
Grain Size Distribution, etc
TCE Found in Site Characterization
Go

Site Remediation

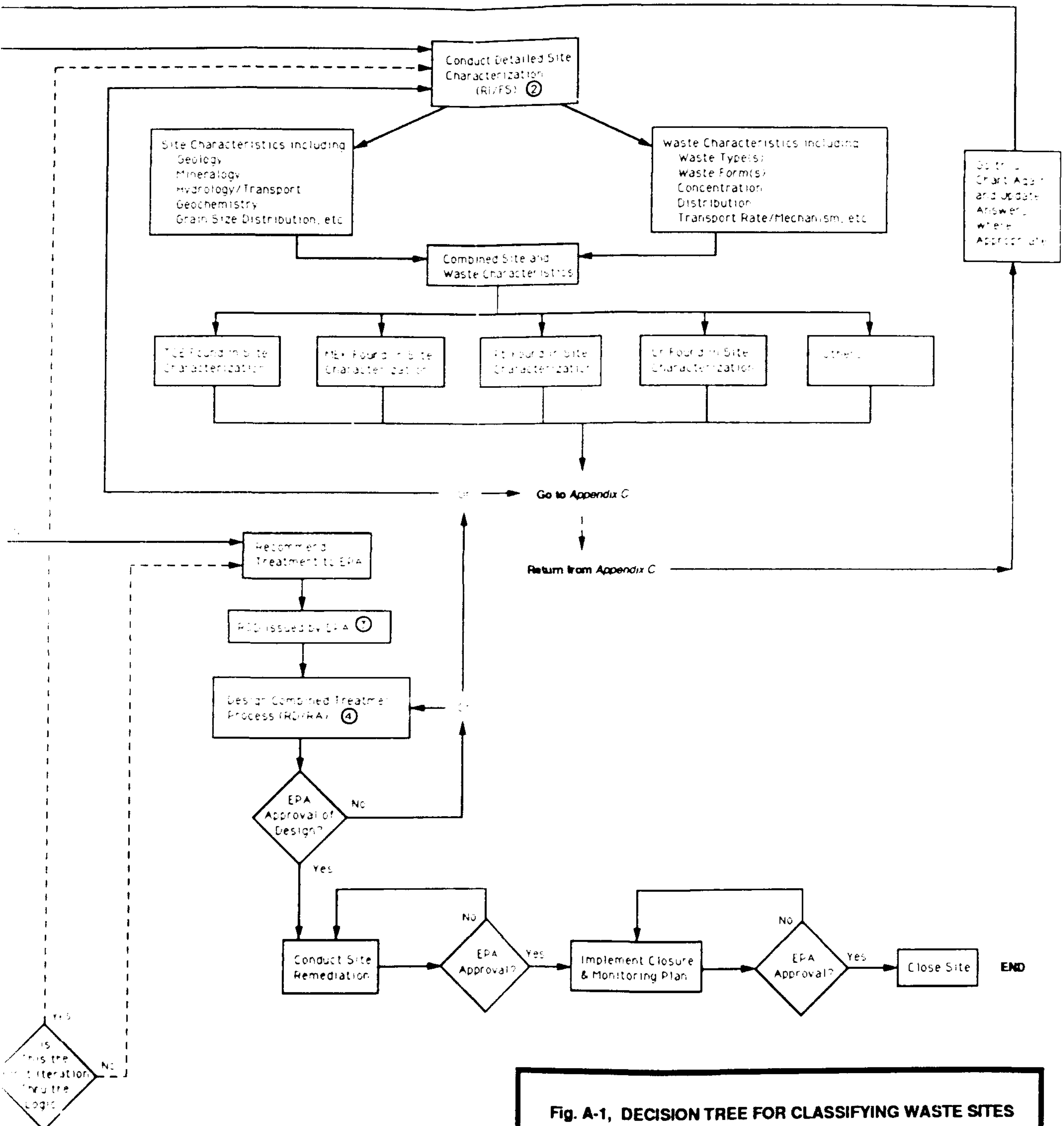


Fig. A-1, DECISION TREE FOR CLASSIFYING WASTE SITES

Prepared by Los Alamos National Laboratory
Los Alamos, New Mexico

for

UNITED STATES ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
(USATHAMA)

3/21/90

APPENDIX A

TABLE OF WEIGHTING FACTORS FOR FIGURE A-1, DECISION TREE FOR CLASSIFYING WASTE SITES

Determine if Site Poses an Imminent Health Risk to Public

A1. Do waste constituents in soil contain sufficient quantities of toxic organics or heavy metals to be a health risk?

	Factors
Very high concentrations	15
Moderately high concentrations	8
Low concentrations	2

A2. Do waste constituents in ground water contain sufficient quantities of toxic organics or heavy metals to be a health risk?

	Factors
Very high concentrations	15
Moderately high concentrations	8
Low concentrations	2

A3. Do waste constituents in surface water contain sufficient quantities of toxic organics or heavy metals to be a health risk?

	Factors
Very high concentrations	20
Moderately high concentrations	10
Low concentrations	5

A4. Do waste constituents in air contain sufficient quantities of toxic organics or heavy metals to be a health risk?

	Factors
Very high concentrations	20
Moderately high concentrations	10
Low concentrations	5

Determine the Physical Setting of the Site

B1. Is site in close proximity to ground water supplies that are used for domestic or agricultural purposes?

Distance	Factors
30 ft (9 m) or less	15
30 ft (9 m) to 100 ft (30 m)	10
100 ft (30 m) to 300 ft (90 m)	5
Greater than 300 ft (90 m)	1

B2. Is site in close proximity to surface water supplies that are used for domestic or agricultural purposes?

Distance	Factors
300 ft (90 m) or less	15
300 ft (90 m) to 1000 ft (300 m)	10
1000 ft (300 m) to 3000 ft (900 m)	5
Greater than 3000 ft (900 m)	1

B3. Is waste in a secure containment(s)?

Distance	Factors
Uncontrolled	15
Lined/diked pit, trench, or pad	8
In sealed containers	2

B4. Is access to site controlled?

Distance	Factors
Uncontrolled	15
Limited area with fence	8
Fenced and guarded	2

Determine if Site is ject to Rapid, Uncontrolled Releases to Biosphere

C1. Are waste forms combustible?

	Factors
Explosive or spontaneous	20
Moderate to high combustibility	15
Low combustibility	5
Noncombustible	0

C2. Is waste site subject to flooding?

	Factors
High probability	15
Moderate probability	10
Low probability	5

C3. Is waste site subject to wind/weather damage or dispersal (tornadoes, hurricanes, wind storms, lightning, etc.)?

	Factors
High probability	10
Moderate probability	5
Low probability	2

C4. Is waste site subject to other natural/manmade disasters or disturbances that could damage or disperse waste forms (earthquakes, forest fires, artillery impacts, etc.)?

	Factors
High probability	10
Moderate probability	5
Low probability	2

Select Applicable Federal Laws and Regulations That Must be Complied With (see Appendix B).

D1. Do federal regulations require early or immediate remedial action?

	Factors
Immediate Environmental Remediation	20
Immediate interim action	10
Eventual Environmental Remediation	5

D2. Can site be permanently closed without remediation?

	Factors
Yes	20
No	0

Determine if Site is a Major Societal or Political Issue.

E1. Are there any major local (or regional) societal or political issues?

	Factors
Considerable press/media coverage	20
Some press/media coverage	10
No press/media coverage	0

E2. Is There Likelihood of Societal or Political Issues Before Scheduled Remediation?

	Factors
High probability	8
Moderate probability	5
Low probability	2

Determine the Estimated Costs to Remediate Site.

F1. What is estimated cost of site characterization?

	Factors
Greater than \$1.5 M	20
\$1.0 M to \$1.5 M	14
\$0.5 M to \$1.0 M	7
Less than \$0.5 M	0

F2. What is estimated cost of waste treatment?

	Factors
Greater than \$1.5 M	20
\$1.0 M to \$1.5 M	14
\$0.5 M to \$1.0 M	7
Less than \$0.5 M	0

F3. What is estimated cost of site closure and monitoring?

	Factors
Greater than \$1.5 M	20
\$1.0 M to \$1.5 M	14
\$0.5 M to \$1.0 M	7
Less than \$0.5 M	0

APPENDIX B

METHODOLOGY FOR SELECTING

APPLICABLE FEDERAL ENVIRONMENTAL REGULATIONS

APPENDIX B

METHODOLOGY FOR SELECTING APPLICABLE FEDERAL ENVIRONMENTAL REGULATIONS

INTRODUCTION

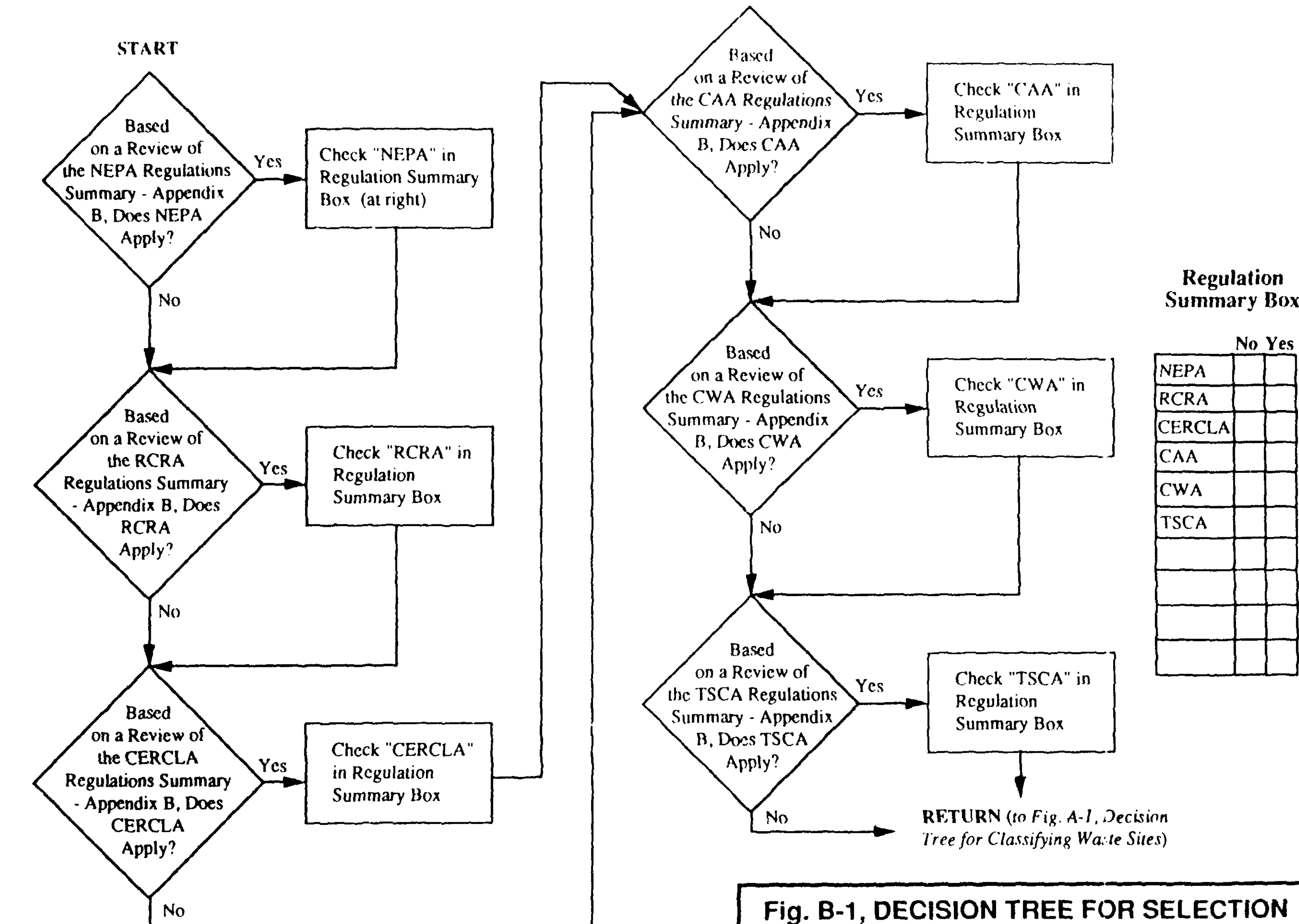
This Appendix provides the methodology for selecting key federal environmental regulations that may apply to a waste site undergoing site classification. In Addition to this introduction, Appendix B consists of the decision tree-type methodology (Figure B-1) and the summary information compiled about each federal regulation that must be reviewed in order to answer the questions posed by the decision tree. Although the decision tree only addresses six key regulations at present, it could be expanded easily to include others (a few candidates are included in the summary listing).

To use the decision tree, first review the question being considered, and then review the appropriate regulation summary information. If the regulation appears to apply based on the summary review, check the "yes" box for that regulation in the "REGULATION SUMMARY BOX" ON THE FORM, Fig. B-1. More than one regulation will often apply to any single site.

Because the regulation summaries do not include every "trigger" for applicability, the results should be used only as a "probable listing" of the key federal regulations that must be complied with during the remediation process. There may also be other federal regulations that will bear on a given site, and there will almost certainly be state or local government regulations (that may take precedence over the federal regulations). There could also be DoD requirements that need to be taken into account.

Finally, it must be cautioned that the federal regulations (and those of states/municipalities) are regularly being changed/expanded; thus, this summary must be

viewed as a "snapshot" that must be updated periodically. If not, it will become increasingly obsolete over time.



NOTE: Names in *italics* are from the other supporting documents.

Fig. B-1, DECISION TREE FOR SELECTION OF APPLICABLE REGULATIONS

USATHAMA 3/22/90 DAY/PLA/LWM

FEDERAL ENVIRONMENTAL REGULATIONS SUMMARY

National Environmental Policy Act (NEPA), 1970

- Sets forth national environmental policy.
- Applies to Federal Agencies (major focus) including DOE, DOI, DoD, etc.
- Requires an Environmental Impact Statement (EIS) for all major federal actions (proposed) that may significantly affect the quality of the human environment (EPA reviews and recommends, while Council on Environmental Quality (CEQ) approves).
- An Environmental Assessment (EA) is prepared to determine if a proposed project will have "significant environmental impact." If so, an EIS is required.
- NEPA does not apply to actions taken under the Clean Air Act by EPA.
- NEPA does not apply to EPA effluent limitations and discharge permits for existing sources of water pollution.
- NEPA does apply to discharge permits for new sources of water pollution.
- NEPA does not apply to pesticide use covered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
- NEPA does not apply to forest clearcutting covered under the National Forest Management Act.
- NEPA does not apply when there is "clear and unavoidable conflict" with another federal statute.
- NEPA does not apply where another federal statute requires "functionally equivalent" review action.
- NEPA can be exempted by the CEQ under "emergency circumstances" (on case by case basis only).
- NEPA does apply to military projects.
- States with "little NEPAs:" California, Connecticut, Hawaii, Indiana, Maryland, Massachusetts, Minnesota, Montana, New York, North Carolina, Puerto Rico, South Dakota, Virginia, Washington, Wisconsin.

Resource Conservation and Recovery Act (RCRA) 1976, Amended in 1980, 1984 (HSWA)

- RCRA, itself is an amendment to the Solid Waste Disposal Act.
- Primary emphasis on current and prospective generation, treatment and disposal of solid and hazardous wastes including some discharges to groundwater and air emissions (i.e., incinerator discharges).

- **Hazardous and Solid Waste Amendments (HSWA) (1984)** focused on historic solid waste activities at facilities subject to permitting (i.e., non-Superfund sites).
- Comprehensive Environmental Response Compensation and Liability Act (CERCLA-1980) is primary tool for cleaning up sites created by past waste disposal practices, or spills of hazardous substances.
- RCRA Covers: hazardous waste (Subtitle C), solid waste (nonhazardous) (Subtitle D), UG storage tanks (Subtitle I), medical waste (Subtitle J), resource recovery and reuse (Subtitle F) and others.
- Subtitle C (hazardous waste) creates cradle-to-grave tracking requirement for industry and government entities.

- RCRA requires that a "hazardous waste" be a solid waste," but solid waste definition includes solids plus air and water treatment "sludges" including solid, liquid, semi-solid or contained gaseous materials. Excluded are solids or dissolved solids in domestic sewage, irrigation return water or industrial discharges which are point sources, or source, special nuclear, or byproduct materials as defined by the Atomic Energy Act of 1954 as amended.
- RCRA hazardous waste is a "solid waste" that is hazardous to health or the environment, inherently or when used improperly.
- There are "listed" hazardous wastes (inherently bad) and "characteristic" hazardous wastes (i.e., ignitable, corrosive, reactive, toxic).
- Excluded from listing are residue from fossil fuel combustion, mining wastes, oil and gas refining, geothermal, and test samples.
- Containers are considered hazardous waste if residue is ≥0.3% by wt. of total capacity if over 110 gal, or 3% if <110 gal capacity.
- "Large quantity generator" produces >1000 kg of hazardous waste per month.
- "Moderate quantity generator" produces 100 to 1000 kg waste per month.
- "Small quantity generator" produces <100 kg waste per month.
- Waste stored >90 days may result in holder having to go through site closure - very expensive!
- Waste generators responsible for: hazardous determinations, proper packaging and labeling, manifests, waste minimization program (new, not yet enforced), and filing of biennial reports on previous year's activity.
- Treatment, storage, and disposal facilities (TSDF) require permits before construction, before operation, and before closure of the hazardous waste management facility. (Some exceptions apply for farmers, totally enclosed facilities, neutralization facilities, spills, transporters if <10-day storage, some recycling facilities, and some municipal waste incinerators -- see 40 CFR §264.1).
- RCRA permit applications are in two parts: Part A, interim status application, calls for general information on how regulations will be met; Part B, final permit application, requires detailed information.
- RCRA required all treaters, storers, and/or disposers to either have permits by November 1980, or qualify for interim status, by notifying the EPA of the operation and agree to "timely" filing for a Part A permit). (HSWA (1984) added requirement for "timely" filing for a Part B permit also -- or loss of interim status.)
- Land disposal facilities, incinerators, and "all other existing facilities" were required by HSWA to have permits.
- HSWA allows for special research, development, and demonstration permits (1-year, renewable up to 3 times) for treatment technology development.
- HSWA requires corrective action of prior hazardous waste releases as a condition of granting a RCRA permit (i.e., before you can have a new TSDF, you have to agree to clean up old waste sites).
- RCRA allows states with regulations that are "equivalent", "consistent", and with "adequate enforcement" to RCRA to be "authorized" or given enforcement authority. A number of the "authorized" state programs are more stringent than the federal program. EPA gives close oversight even if a state has an "authorized" RCRA type program.

- A technical difference exists if permits are granted by a "authorized" state-such permits are non HSWA. EPA, under the federal RCRA program, issues HSWA permits (few states have HSWA permit) and enforcement authorization. EPA's federal permitting requirements are in 40 CFR Part 270.
- RCRA requires extensive groundwater monitoring at hazardous waste facilities (landfills, impoundments, treatment facilities).
- HSWA added similar monitoring requirements to interim status facilities as RCRA requires for new ones [some exceptions are made based on design/construction parameters as defined in 40 CFR §264.90(b)(1),(2)].
- HSWA imposed land disposal restrictions including 1) banning all "listed" and "characteristic" hazardous wastes (unless EPA determines no health hazard will result).
- "Land Disposal" includes landfills, surface impoundments, waste piles, injection wells, land treatment facilities, salt dome or bed facilities, or underground mines or caves.
- Non-containerized bulk waste liquids are banned from salt formations or mines/caves after 1984.
- Non-containerized bulk waste liquids are banned from landfills after 1985.
- Dioxen-containing wastes and solvents banned after 1986.
- Liquids containing metals, PCBs, and halogenated organic compounds banned after 1987.
- By May 1990 all listed hazardous wastes are to be banned from land disposal (or exceptions can be granted by EPA only if no health hazard exists and no migration will occur).
- EPA has set some treatment standards for listed hazardous wastes that if met will allow land disposal.
- EPA treatment standards specifically state that "dilution is not a valid treatment" (40 CFR §268.44).
- Non-hazardous waste regulations (community dumps) are under RCRA Subtitle D Program.
- Enforcement largely in state's perview, but HSWA established federal controls for open dumping.
- States develop 5-year plans for non-hazardous waste management (40 CFR Part 256).
- "Sanitary landfills" (with "no reasonable probability of adverse effects on health or environment") are to replace "open dumps" (those not meeting criteria in 40 CFR Part 257, as revised in 53 Federal Regulation 33314, August 30, 1988).
- Underground storage tanks (USTs), RCRA Subtitle I regulates USTs with hazardous substances.
- In 1988 EPA UST regulations (40 CFR Part 280) became law (RCRA Subtitle I).
- Includes both hazardous products (i.e., petroleum products etc.) and hazardous wastes.
- "Underground" means ≥10% of volume below surface (~2,000,000 such tanks in the U.S.).
- Farm and residential tanks ≤110 gal for noncommercial fuel storage, septic tanks, surface impoundments, pits, ponds, lagoons, storm/wastewater collection systems etc., exempted.
- RCRA requires leaking tanks be replaced.
- RCRA establishes monitoring and record-keeping requirements for existing tanks.
- RCRA establishes new tank construction/materials/installation/monitoring requirements.

- By December 1998, all tanks must meet new tank standards and piping must meet new piping standards (some states have accelerated schedules) as defined in 40 CFR Part 280.
- UST's temporarily closed for more than 12 months must be permanently closed unless they meet new tank standards (a 12 month extension can be requested if a closure assessment is performed).
- Hazardous substance tanks (non-petroleum) must meet all new tank standards plus have a secondary containment structure.

Comprehensive Environmental Response Compensation and Liability Act (CERCLA or Superfund), 1980, Amended 1986 by Superfund Amendments and Reauthorization Act (SARA)

- Provides funding and enforcement powers for cleanup of past (pre-1980) hazardous waste activities on non-federal facilities.
- Funding derived from tax on chemical and petroleum industries, plus cost recovery actions. Funding for federal facilities is derived from congressional appropriation.

- Originally CERCLA had few regulations (in contrast to RCRA), but SARA (1986) codified many actions taken by EPA between 1980-1986 (effectively added regulatory requirements).
- CERCLA definition of "Hazardous Substances" (in contrast to RCRA "Hazardous Waste") is much broader, encompassing CWA, RCRA, TSCA, etc. definitions. But, excludes petroleum and natural gas, (except, "used oil" that contains hazardous impurities may be included).
- Under CERCLA, "Release" covers virtually any means by which a substance enters the environment (including the abandonment of closed drums/containers).
- Under CERCLA, "Facility" includes buildings, installations, containers, landfills, or impoundments (basically, any area where hazardous substances are located).
- Under CERCLA, "Environment" includes surface and groundwater, ambient air, land, and subsurface anywhere in the United States.
- Under CERCLA, release of hazardous substances above "reportable quantities" must be reported to EPA National Response Center and usually to the public (SARA Title III) under penalty of law.
- Some RCRA-regulated facilities and those with "federally permitted releases" are exempt from notification (unless release exceeds permit limits).
- CERCLA required owners/operators and transporters to report hazardous waste facilities to EPA by 1981.
- Over 20,000 such facilities were reported, and subsequently are being rated for NPL qualification.
- Under CERCLA, there are "removal" actions (≤12 months, $2 M) and "Remedial" Actions (long-term solutions).
- State and EPA agreement required for "Remedial" Actions with state funding for 10% (or 50%, if publicly operated facility) of remedial action cost.
- Remedial actions can be performed by EPA only at NPL listed sites.
- EPA has considerable discretion for listing sites including rating system based on waste volume, toxicity, distance to population and/or drinking water supplies, plus potential health and environmental effects (broad discretion under H and E effects).

•Superfund Comprehensive Accomplishment Plan (SCAP) is quarterly planning document.

- National Contingency Plan (NCP), sets forth procedures that MUST be followed when performing superfund site cleanup. It includes guidelines for: (1) method to select remedy, (2) potential deferral of cleanup to RCRA, (3) involvement of public and states in the Remedial Investigation/Feasibility Study (RI/FS) process.
- NCP describes RI/FS process for remedial actions after NPL listing.
- Following multiyear and expensive RI/FS process, EPA will select a proposed remedy from the alternatives presented and then present to public for review/comment.
- After comments received/addressed, a RECORD OF DECISION (ROD) is issued to set forth the remedy that will be implemented & rationale for its selection by EPA.
- Normally cleanup does not start until the RI/FS process is completed, but in special cases an "operable unit" designation may be given, and specific near-term actions taken to effect immediate resolution of specific problems.
- Private parties are not allowed to initiate a remedial action once the RI/FS process is started (unless EPA gives specific approval).
- SARA lists factors to be considered (by EPA) for selecting a remedy: Treatment is preferred over disposal, health and environment are important, cost effectiveness is important.
- Treatment must meet "applicable or relevant and appropriate requirements" (ARARs) under RCRA, TSCA, CWA, CAA, and any state standards that are more stringent.
- Six ARAR exceptions: (1) remedial action is part of larger action that meets ARAR, (2) complying with ARARs is greater risk than other options, (3) ARAR is technically impracticable, (4) remedial action will be equivalent to ARAR, (5) state ARAR need not be followed if the state has not consistently applied it, and (6) if costs for ARAR approach is too expensive and limits $ for other sites.
- States may challenge EPA's selection of a remedy, but other challenges (public) are very limited.
- After the ROD is issued, the selected remedy is designed and implemented, called Remedial Design/Remedial Action (RD/RA).
- The RD-phase does provide for specific testing/optimizing of the selected remedy.
- EPA reviews remedies (like caps or other on-site materials) every 5-years to assure public health. If review shows more work is needed, EPA can reopen the matter.
- EPA superfund dollars are maintained in the multibillion Hazardous Substance Response Trust.
- The definition of "owner/operator" of a waste site has a very broad interpretation and thus liability for cleanup costs can be assigned to individuals, companies, or others with influence on facility operations (including lenders and states).
- Under SARA, there is an innocent landowner exception (very limited), and requires that "due diligence" be used when purchasing to determine if any contamination might exist.
- Liabilities of past owners/operators is also very broad and can go back generations if waste disposal was part of their operation (past owners who can show they did not dispose of waste are not liable).
- Superfund cost recovery (liabilities of "potentially responsible parties"-PRPs) can cover all costs for personnel, contracts, overhead etc., and even interest (SARA 107(a)).
- Liability can also include up to $50 M damages for natural resource damages (will be increasingly applied) based on lesser of "use value" or "restoration value", for post 1980 sites.

- Liability is held to be "joint and several" meaning as few as one prior PRP could be required to pay more than his "fair share" (up to all costs)
- Contribution Rights/Contribution Action Protection, under SARA, gives right to liable parties to seek restitution from other liable parties-promotes cost sharing among PRPs.
- Defenses to liability are very few, but include "Acts of God", "Acts of War", and certain "Actions of a third party" (only if a "complete absence of causation" can be shown).
- PRPs are allowed to perform RI/FS if deemed "qualified," but must also pay for EPA oversight.
- PRPs are allowed to perform RD/RA per the ROD terms and conditions (EPA, however, is responsible for selecting the remedy from results of the RI/FS, and preparing the ROD).
- Mixed government and PRP funding is possible under Superfund (but rarely used).
- EPA prefers to use "surrogate" mixed funding in which EPA waives certain costs (usually past or future monitoring costs).
- Under SARA EPA has authority to perform "nonbinding preliminary allocations of responsibility" (NBARs), based mainly on volume of waste (per PRP) and operator proficiency. EPA, thus far, does not perform NBARs, preferring to leave allocations to the PRPs.
- EPA, under Section 106 Administrative Orders, can unilaterally specify work to be done at a site (a powerful tool with possible fines up to $25K/day for noncompliance, and being used more and more by EPA to force cleanup actions).
- Very difficult for PRPs to show "sufficient cause" to not comply with a 106 Order-but after a 106 Order is issued the PRP can meet with EPA to confer (negotiate) on the means of implementation.
- States, municipalities, and private parties can bring certain common law actions against PRPs based on: (1) nuisance; (2); trespass; (3) negligence; (4) ultrahazardous or abnormally dangerous activities.

Clean Air Act (1963) Administered by EPA and states and local authorities

- To control and abate outside air pollution from mobile and stationary sources.
- Title I - stationary sources, Title II = mobile sources, Title III = general administration, citizen suits, judicial reviews, Title IV = noise control (in 40 CFR Parts 50-99).
- States required to adopt State Implementation Plans (SIPs) for primary enforcement.
- Amendments added in 1963, 1967, and 1970 (important because it establishes National Air Quality standards and National Emission Standards for Hazard Air Pollutants - "NESHAPS"), and 1977 (set compliance deadlines and prevention of significant deterioration - "PSD" provisions with permit requirements for new source construction).
- Ambient Air Quality standards (NAAQs) have been issued for six "criteria" pollutants: sulfur oxides, particulate matter (dust), carbon monoxide, ozone, nitrogen dioxide, and lead.
- Primary NAAQs based on health protection only.
- Secondary NAAQs based on public welfare and cover effects on soil, waters, crops, vegetation, animals, property, visibility, and personal comfort and wellbeing. Secondary NAAQs may be stricter than primary.
- National Emission Standards - Apply only to new or modified stationary sources.

- New Source Performance Standards (NSPS) enforced by EPA and states having comparable laws.
- Prioritized listing of 59 categories of new stationary sources in 40 CFR Part 60 §60.16.
- National Emission standards for Hazardous Air Pollutants ("NESHAPS") - Applies to new and existing stationary sources at point of emission. Eight pollutants presently listed: asbestos, benzene, berylium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride
- 25 Other pollutants assessed as hazardous in 40 CFR Part 61 §61.01(b).

Clean Water Act (1972 w/revisions in 1977, 1978, 1981, 1987 - Water Quality Act of 1987)

- Goal to restore and maintain chemical, physical, and biological integrity of Nation's waters.
- Protect fish, shellfish, wildlife and recreation resources and eliminate discharge of pollutants (by 1985).
- Covers non-point sources such as agriculture, mining, and construction (runoff), dredging and oil and hazardous subs.
- Requires permits (EPA and/or state) for discharges; disclosure of discharges, monitoring, and limitations.
- Sets standards for various pollutants including aldrin/dieldrin, DDT/DDD/DDE, endrin, toxaphene, benzadrine and PCBs (six health-based toxic pollutants; other hazardous substances in 40 CFR Part 116).
- Quality Criteria for Water (1986) lists 137 specific pollutants (CWA §304(a).
- Covers Point Source discharges including: dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, chemical waste, biological waste radioactive material, heat discarded material, rock, sand, cellar dirt, industrial waste, and agriculture waste into navigable waters (almost all waters).
- Requires notification of state and EPA within 24 hours of a spill or accidental release above imposed limits.
- Hazardous substance releases (unplanned) require immediate notice to appropriate agency.

Toxic Substances Control Act (TSCA) - <u>(1976) Focus on Manufacturing and Processing</u> of chemical substances rather than on disposal or resulting pollution.

- TSCA takes a backseat to other laws/statutes if they control an activity or substance.
- TSCA is primary federal statute covering <u>PCBs</u> (handling and disposal) and increasingly will be used for <u>asbestos</u>, <u>radon abatement</u>, and (soon) <u>lead</u>.
- TSCA has been a slow starter, but will become increasingly important as more substances are added from <u>required</u> chemical testing of new or suspected hazardous substances or processes
- TSCA gives EPA authority to: ban, limit use, set labeling requirements, records requirements, disposal requirements, seizure if imminent risk, and sets forth public disclosure of risk.

The summary information on the following federal regulations is provided for information purposes only. They have no direct bearing on the decision tree for selection of applicable regulations as presently developed.

Atomic Energy Act 42 U.S.C. §2011 - Administered by NRC. EPA sets standards for public health protection

- Covers use of source material, by product and special nuclear material.
- Regulations on radiation wastes set forth in 40 CFR Parts 190-192.
- Low-level waste governed by low-level Radioactive Waste Policy Act (42 USC §2021(b)a.
- High-level waste governed by Nuclear Waste Policy Act (42 USC §10101).

Occupational Safety and Health Act (1970) - Administered by Dept. of Labor or states with laws as stringent as the federal law

- Does not apply to United States government or state/local governments.
- Covers exposure to chemicals, labeling requirements, precautions, protective equipment and monitoring procedures.
- OSHA standards set forth in 29 CFR Part 1910.
- DOE complies with OSHA Parts 1910 (General Industry), 1926 (Construction), plus a few others, and uses DOE orders to cover other OS&H activities.

Safe Drinking Water Act - Controls water quality "at the tap" (focus on contaminant removal)

- Enforcement is usually by individual states which have adopted "no less stringent laws."
- Applies to public water systems with ≥15 service connections and regularly serve ≥25 people.
- Sets enforceable national standards, maximum contaminant level goals and maximum contaminant levels.
- Underground Injection Control Program - Protects underground sources of drinking water.
- Ground Water Protection - to protect "sole source aquifers" supplying public drinking water.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

- Requires registration for distribution, sale and shipment and labeling standards.
- Applies to any person who owns, controls, or has custody over the pesticide.

Hazardous Materials Transportation Act (HMTA)

- Administered by Department of Transportation (DOT) in coordination w/EPAs RCRA implementation.
- Applies to hazardous materials transporters and manufacturers of packages and containers for shipping hazardous materials set forth in 49 CFR Part 172.

Noise Control Act of 1972

- Sets noise emission standards - administered by EPA Assist. Administrator for AIR (except aircraft).
- Applies to construction equipment, transportation equipment, motors and engines, electrical and electronic equipment.
- Regulations set forth in 40 CFR Parts 201-210 (1984).

Coastal Zone Management Act - Administered by Dept. of Commerce or states (30 states and 5 territories)

- Federal activities in CZM area must be consistent with CZM plan (criteria in 16 U.S.C. §1454).

Deep Water Port Act - Administered by DOT

- Offshore oil terminals main focus.

APPENDIX C

METHODOLOGY FOR SELECTION

OF

POSSIBLE TREATMENT TECHNOLOGIES

APPENDIX C

METHODOLOGY FOR SELECTION OF POSSIBLE TREATMENT TECHNOLOGIES

Introduction

This appendix is utilized in two places on the Decision Tree for Classifying Waste Sites (Figure A-1). The following text, describing the various treatment technologies, is used on the Site Classifier side of the decision tree for obtaining a preliminary estimate of waste treatment costs, in response to question F2. This appendix is also used on the Site Remediation side of the Decision Tree for Classifying Waste Sites for the purpose of compiling a list of possible treatment technologies. For this process, the Appendix C treatment technologies descriptions are used in conjunction with the attached Procedure for Selection of Possible Treatments (Figure C-1) and the Treatment Selection Table (Table C-1). After utilizing this Appendix for the intended purpose, it is necessary to return the appropriate point in Figure A-1.

Waste treatment processes are generally designed to do one of three things: (1) extraction and concentration of the waste reduces the volume and makes it more amenable to further processing and facilitates the safe handling and disposal of the hazardous components; (2) destruction transforms the hazardous components into non-hazardous constituents or a form safe for disposal; (3) immobilization isolates the wastes from the accessible environment. The following summary of waste treatment technologies is divided into these three process sections. When available, the efficiency of the treatment process and cost estimates are provided.

It should be noted that the treatment methodologies will list several contaminants that can be treated under the proper conditions; however, some technologies will have severe limitations for a given set of waste and site-specific conditions. The post site characterization screening of corrective measure technologies focuses on eliminating those technologies. Also, note that "Excavate, Transport, and Rebury" is not listed in this appendix because it is not considered to be a treatment, although it may be a viable remedy.

Costs for in situ treatment can vary widely. The selection of an in situ technology will depend upon the contaminant characteristics and whether or not the contamination has reached the water table. The remediation technology may treat both the groundwater and soil, or separate technologies may be required to treat each. Local site geologic and hydrologic characteristics will also determine the feasibility and economics of technology selection. Also, multiple processes may be needed in a stepwise process. For example, it may be necessary to follow an extraction technology with a destructive technology, which in turn may be followed by an immobilization technology before safe disposal can be accomplished.

Technologies identified as developmental may not yet be available for full-scale field use. Numbered treatment methodologies are utilized in the attached Treatment Selection Table (Table C-1). Numbers correspond to the treatment numbers in Column 4 of that chart. Treatment methodologies preceded by one asterisk (*) are included for information only.

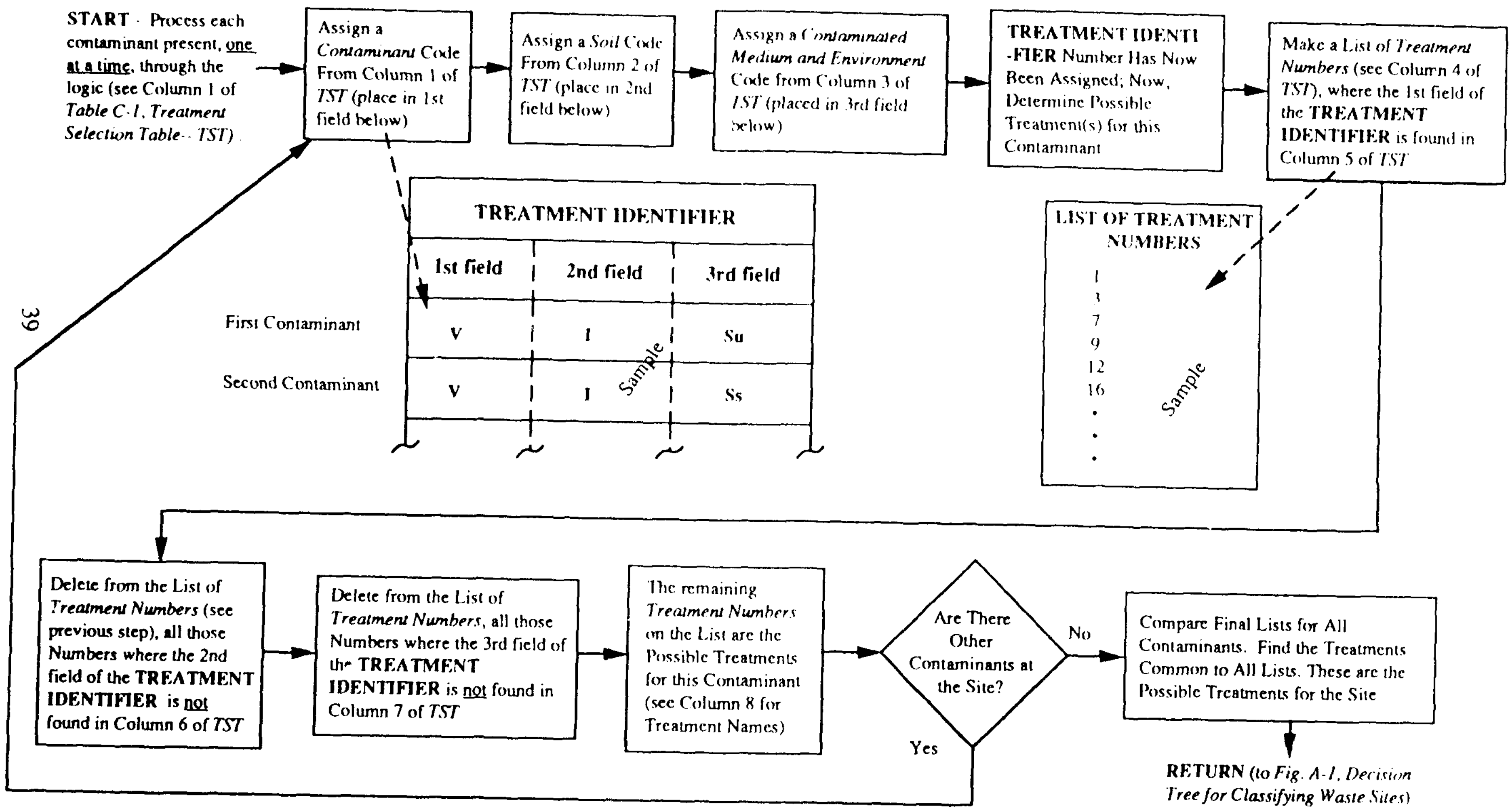


Fig. C-1, PROCEDURE FOR SELECTION OF POSSIBLE TREATMENTS

USATHAMA

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DAY:PLA/I WM

NOTE: Names in *italics* are from the other supporting documents.

Table C-1, TREATMENT SELECTION TABLE

SITE CHARACTERIZATION DATA

Column 1 **Contaminant** (by Category)	Column 2 **Soil** (by Category)	Column 3 **Contaminated Medium and Environment**
Code	**Code**	**Code**
V = VOCs (incl. TCE, MEK, etc. but not Fuels; see F)	I = Gravel	Su = Soil, Unsaturated (in Vadose Zone)
F = Liquid Fuels (incl. Gasoline, Diesel, Aviation Fuel, etc.)	I = Sandy Gravel	Ss = Soil, Saturated Zone
O = Non-Volatile Organics	I = Sand	GW = Groundwater
M = Heavy Metals (incl. Pb, Cr, etc.)	I = Silty Sand	SW = Surface Water
X = Explosives	S = Silt	WS = Waste Stream
P = PCBs	S = Clayey Silt	
R = Radionuclides	S = Clay	

TREATMENT DATA

Column 4 **Treatment Number**	Column 5 **Contaminant to be Treated**	Column 6 **Treat In-Situ vs. Surface**	Column 7 **Medium and Environment of Treatment**	Column 8 **Possible Treatment** **
				EXTRACTION
				Volatilization
1	V, F	I	Su	Vacuum Extraction
2	V, F	S	GW, SW, WS	Air Stripping (tower)
3	V, F	S	Su	Thermal Stripping (low temp.)
4	V, F	I	Su	RF Thermal Stripping
5	V, F, O	S	GW, SW, WS	Steam Stripping (surface)
6	V, F, O	I	Su, Ss	Steam Stripping (in situ)
7	V, F, O	S	WS	Distillation
8	V, F, O, M, X, R	S	Ss, GW, SW	Evaporation
9	V, F, O, M, X, R	S	Su, Ss	Soil Washing (surface)
10	V, F, O, M, X, R	I	Su, Ss	Soil Washing (in situ)
11	M, R	S	GW, SW, WS	Ion Exchange
12	V, F, O, M, R	S	GW, SW, WS	Reverse Osmosis
13	V, F, O, M, X, R	S	GW, SW, WS	Carbon Adsorption
14	V, F, O	S	Su, Ss, WS	Supercritical Fluid Extraction
15	M, R	S	GW, SW, WS	Precipitation
				DESTRUCTION
				Incineration
16	V, F, O, M*, X	S	Su, WS	Rotary Kiln
17	V, F, O, M*, X, P	S	Su, WS	Fluidized Bed
				Pyrolysis
18	V, F, O, M*, X, P	S	Su, Ss, WS	Infared
19	V, F, O, M*, X, R*	S	Su, Ss, WS	Plasma Arc Furnace
				Oxidation
20	V, F, O, M*, X	S	WS	Wet Air
21	V, F, M*, X, P	S	Su, Ss, GW, WS	Supercritical Water Oxidation
22	V, F, P	S	GW, SW, WS	Ozonation
23	V, F	S	GW, SW, WS	Catalytic Decontamination
24	V, P	S	Su, Ss	Chemical Detoxification (surface)
25	V, P	I	Su, Ss	Chemical Detoxification (in situ)
				Biodegradation
26	X, O	S	Su, Ss	Composting
27	V, F	S	Su, Ss	Land Farming
28	V, F, X	S	Su, Ss, GW, SW, WS	Aerobic Biodegradation (surface)
29	V, F, X	I	Su, Ss, GW	Aerobic Biodegradation (in situ)
				IMMOBILIZATION
30	M, R	S	Su, WS	Cement Based Processing
31	M, R	S	Su	Vitrification (surface)
32	M, R	I	Su	Vitrification (in situ)

Legend:

I = in situ
S = surface

* = Metals are concentrated in the process, not destroyed.

** = "Excavate, Transport, and Rebury" is not considered to be a treatment.

TREATMENT INDEX

TREATMENT SUMMARIES

EXTRACTION

* VOLATILIZATION - Volatilization technologies take advantage of the high vapor pressures of VOCs to remove them from contaminated soils and ground water. This technology will work for any volatile compound in nearly any soil condition. In-situ remediation is usually accomplished by boring a series of wells through which either a vacuum is drawn or pressurized air is injected. The terms vacuum extraction or air stripping are often used to describe this process. Methods for heating the contaminated soil are often used to increase the contaminant volatility and, increase extraction rates. Costs for remediation of unsaturated soils at sites contaminated with VOCs are reported to be as low as $3.00 per cubic yard of soil, although $20.00 is more typical, provided no measures are taken to control emissions. For processes exercising rigid control over air emissions, the costs can range as high as $250 to $300 per cubic yard. Several volatilization technologies are described below.

1 Vacuum Extraction, in situ - This method is most applicable for contamination at depths greater than 40 ft in fairly permeable soils. A vacuum is applied to venting wells. Gases are extracted from the soil and fed into the treatment system. Air injection will aid air throughput. This method is inexpensive, especially if the emissions require no treatment. If the contamination includes toxic volatile organic carbons, then treatment of the vented gases would be required. Costs can be as low as $15/ton if emission treatment is unnecessary; with activated carbon, costs could be around $85/ton.
VOCs from unsaturated soils
chlorinated solvents
fuels

2 Air Stripping, countercurrent - A relatively inexpensive and low maintenance operation. Depending on the contaminant, the method can be about an order of magnitude less expensive for a similar level of treatment with activated carbon. Water can be treated and reinjected or surface disposed. VOCs are transferred to the air. Contaminated air may require treatment. TCE removal from groundwater has been reported to be as low as $0.12/1000 gallons.
trichloroethelene
many other VOCs

2 Air Stripping, rotary - Similar process as countercurrent air stripping, but because of moving bed and more moving parts, higher maintenance costs can be expected. The method would be more efficient than the countercurrent method for somewhat less volatile organics. Treatment costs were found to be $0.40 to $0.50/1000 gallons.
VOCs

3 Low Temperature Thermal Stripping of VOCs from soils - Applicable sites include fire training pits, burn pits, spills, and lagoons. Contaminated soil is fed into a thermal processor via a hopper or screw system where volatilization occurs. Contaminants having boiling points of up to 260° C have been removed. This is a media transfer technique rather than a destructive technique, so treatment of gaseous effluent prior

pilot testing or implementation. A large-scale pilot test has been conducted. Costs to treat 15,000 and 80,000 tons of contaminated soil would be approximately $160/ton and $74/ton, respectively, without flue gas treatment. If afterburner exhaust gases are treated prior to discharge, the respective costs are $184/ton and $87/ton.

Chlorinated solvents
- trichloroethylene
- dichloroethylene
- tetrachloroethylene
- xylene

Fuels

4 Radio Frequency (RF) Thermal Soil Decontamination - This is an in situ method. This method is similar to soil venting, except that RF power supplied to electrodes in the soil heats it above 150°C, vaporizing contaminants and moisture. The method is most economical when less than one acre must be treated. The method is applicable to such sites as fire training pits, spills, and sludge pits containing solvents. Laboratory and pilot studies are being conducted. Demonstrations have shown higher than 90% reduction of jet fuel components from soils. Estimated costs for a 3-acre site, 8 ft. deep, with 12% moisture are $42/ton.

VOCs

5 Steam Stripping (surface) - Most efficient when the contaminant is highly volatile and only slightly soluble in water. Heated waste streams are fed into a tower filled with packing material or trays. As the waste flows downward through the tower, steam passes countercurrent to the stream. Organic contaminants that have volatilized are carried away in the steam. This method may be used to treat solutions with organic concentrations ranging from 100 ppm up to 20%. Properly sized solid materials can also be treated with similar type processes. Steam stripping is most efficient when the contaminant is highly volatile and only slightly soluble in water. The local price of steam is the main consideration in determining the economic feasibility of a steam stripping operation.

methylethyl ketone
acetone
volatile organic compounds
hydrogen sulfide
ammonia
Clorinated hydrocarbons
- 1,1,2-trichloroethane
- carbon tetrachloride
- 1,2-dichloropropane

6 Steam Stripping (in situ) - Steam injection wells are placed to optimize steam penetration into the contaminated zone. A vacuum is applied to venting wells. Contaminants are extracted from the soil and fed into the treatment system. Cost estimates for this process would be similar to that of Vacuum Extraction, plus the cost of the steam.

VOCs
Fuels

7 Distillation - This technique uses evaporation and condensation to separate the more and less volatile components in a feed stream.
Solvents

8 Evaporation - Primarily used as a pre-processing step for concentrating or removing contaminants of concern, as the hazardous component of the waste is not destroyed. A second processing step is required to immobilize or to destroy the hazardous components. Normally used to reduce the water content of aqueous slurries or sludges, but can also be used to remove the organic material in wastes. A thin-film evaporator system consists of a large diameter heating surface on which a thin film of material is continuously wiped. The volatile portion is vaporized leaving concentrated semi-solids. Concentrated liquid solutions, high viscosity liquids, slurries, sludges, and contaminated soils can be treated.

9,10 SOIL WASHING - Soil washing is the extraction of the contaminant in a suitable solvent, usually water. This technology is amenable to both extract-and-treat or in situ processes. If an in situ approach is taken, it is necessary to have a well characterized site hydrology such that injection/extraction wells or trenches are capable of containing the solvent-solute mixture in a closed loop thereby preventing further leaching into the ground water. Filtration or other physical separation techniques may be required to separate the aqueous wash solution. May be useful if the components of a mixture are more amenable to treat separately rather than mixed together. Washing has been used primarily to remove soluble contaminants from soils, but the technique has also been applied to remove actinides from plastics and other materials not soluble in aqueous media. A representative cost for in situ soil washing is roughly $60 per cubic yard of soil. This reflects the cost of wells and piping, operating costs and maintenance costs for a site of 2000 cubic yards.
Soluble Contaminants from Soils

11 ION EXCHANGE - A reversible process for extracting ions (primarily metal ions) from aqueous wastes. During this process, there is an exchange of ions between the contaminated liquid phase and the solid resin which produces no permanent change to the structure of the resin. When saturated with waste ions, the resins are either disposed or regenerated with appropriate solutions.
Metal Ions from Water

12 REVERSE OSMOSIS (aka Hyperfiltration) - This process uses a semipermeable membrane for extracting uncontaminated water from a volume of water containing dissolved solids. Uncontaminated water is forced through the membrane, while the dissolved solids are concentrated into the remaining, smaller volume of water.
groundwaters
heavy metals
-antimony -lead
-chromium -nickel
-barium -others
organics greater than 90% removal of the following:
chloroform
1,1-dichloroethane
1,2-dichloroethane

1,1,1-trichloroethane
trichloroethane

13 CARBON ADSORPTION - Organic compounds of moderate molecular weight are most easily adsorbed. It is an effective method for removing volatile organic compounds from aqueous wastes. Inorganic contaminants may also be adsorbed. It works by adsorbing organic molecules onto the surface of the carbon particles. It is particularly well suited to the removal of low concentrations of nonbiodegradable compounds. Carbon particles have a high surface area to weight ratio, in the range of 500-1500 square meters per gram, which creates a large surface area for interaction with the organic molecules. At the interior of the carbon, the attractive forces are balanced; however, at the surface the forces are unbalanced. This imbalance results in a net inward attraction which draws the organic molecules to the surface of the carbon. The effectiveness of organic adsorption can be over 99%. For most applications, treatment of an aqueous stream contaminated with 1000 mg/l will cost from $6 to $35 per 1000 gallons; a stream with 10 mg/l will cost from cents to $3 per 1000 gallons. See Table C-2 for treatability ratings of selected priority pollutants utilizing carbon adsorption.

* SOLVENT EXTRACTION - This process transfers a solute compound(s) from one liquid medium to another. This process is becoming increasingly prominent in chemical manufacturing and in wastewater purification. The process is applicable to solvents containing both metallic and organic contaminants. The process involves transfer of the contaminant from the water to the solvent (purification), concentration of the contaminant (solvent regeneration), and removal of solvent from the decontaminated water (solvent recovery). Costs for solvent extraction of polar compounds has been estimated at from $4 to $10 per 1000 gallons of water.

Phenolic compounds
Acetic acid
Polar compounds (research stage)
DDT

14 SUPERCRITICAL FLUID EXTRACTION - Critical or compressed fluid form of an environmentally safe gas (e.g., critical state carbon dioxide or compressed liquid state propane) is used as a solvent to extract organic hazardous constituents from waste. Additional processing steps are required if destruction of the solvents and waste oils is required.

Organic Compounds from Soils
Oil from Sludge
Solvents from Slurries

15 PRECIPITATION - This is a chemical process used to remove inorganic compounds (metals) from hazardous wastes. It is currently one of the most widely used and cost effective technologies for inorganics removal from aqueous wastes provided treatment is done above ground in a tank of some sort. It is used to treat surface waters and waste waters.

metals from water

TABLE C-2

TREATABILITY RATING OF SELECTED PRIORITY POLLUTANTS UTILIZING CARBON ADSORPTION*

Priority Pollutants	Removal Rating**	Priority Pollutants	Removal Rating**
Acenaphthene	H	Methyl bromide	L
Acrolein	L	Dichlorobromomethane	M
Acrylonitrile	L	Trichlorofluoromethane	M
Benzene	M	Dichlorodifluoromethane	L
Benzidine	H	Chlorodibromomethane	M
Carbon tetrachloride	M	Hexachlorobutadiene	H
Chlorobenzene	H	Hexachlorocyclopentadiene	H
1,2,4-trichlorobenzene	H	Isophorone	H
Hexachlorobenzene	H	Naphthalene	H
1,2-dichloroethane	M	Nitrobenzene	H
Hexachloroethane	H	2-nitrophenol	H
1,1-dichloroethane	M	2,4-dinitrophenol	H
1,1,2-trichloroethane	M	4,6-dinitro-o-cresol	H
1,1,2,2-tetrachloroethane	H	N-nitrosodimethylamine	M
Chloroethane	L	N-nitrosodiphenylamine	H
Bis(2-chloroethyl)ether	M	N-nitrosodi-n-propylamine	M
2-chloroethyl vinyl ether	L	Pentachlorophenol	H
2-chloronaphthalene	H	Phenol	M
2,4,6-trichlorophenol	H	Bis(2-ethylhexyl)phthalate	H
Parachlorometa cresol	H	Butyl benzyl phthalate	H
Chloroform (trichloromethane)	L	Di-n-butyl phthalate	H
2-chlorophenol	H	Dimethyl phthalate	H
1,2-dichlorobenzene	H	1,2-benzanthracene	H
3,3'-dichlorobenzidine	H	Benzo(a)pyrene	H
1,1-dichloroethylene	L	3,4-benzofluoranthene	H
2,4-dichlorophenol	H	11,12-benzofluoranthene	H
1,2-dichloropropane	M	Crysene	H
1,2-dichloropropylene	M	Acenaphthylene	H
2,4-dimethylphenol	H	Anthracene	H
2,4-dinitrotoluene	H	Tetrachloroethylene	M
2,6-dinitrotoluene	H	Toluene	M
1,2-diphenylhydrazine	H	Trichloroethylene	L
Flouranthene	H	Vinyl chloride	L
Methylene chloride	L	PCB-1242 (Arochlor 1242)	H
Methyl chloride	L		

* From EPA Treatability Manual.

** NOTE: The removal ratings are based on the mass of compound adsorbed per gram of carbon at equilibrium. A greater mass of a compound rated H will be adsorbed, then a compound rated M, and so on. The actual amount adsorbed will depend on the final concentration of compound in solution.

DESTRUCTION

INCINERATION - Incineration is the most widespread thermal destruction technology. Any residual hazardous material has small volume and is easily managed. Consequently, incineration frees the hazardous waste generator from the liability risks of disposal. Incineration h s the additional advantage of allowing heat recovery. A variety of incinerator types have proven their long-term reliability to destroy hazardous organic compounds. A few of these are briefly described below.

* Fixed Hearth Incineration - These incinerators are usually of small capacity and handle both liquid and solid wastes. Mixed wastes, including waste solvents and combustible solids, can be handled with feed rates of up to one ton per hour. More stable wastes, such as chlorinated liquid wastes are not handled well. Operational costs may range up to $150 per ton for simple combustible wastes.
  Solvents
  Combustible solids

* Liquid Injection Incineration - Waste is injected into the combustion chamber in finely divided droplets vigorously mixed with air. Following combustion, the flue gases are cooled and treated with air pollution control devices to remove particulates and to absorb acid gases. Pretreatment may be required for wastes that are difficult to atomize, vary in heat content, or are not pumpable. Operational costs may range up to $300 per ton of chlorinated solvents.
  Combustible liquid or slurried waste
    Liquid halogenated hydrocarbons
    Chlorinated solvents

16 Rotary Kiln Incineration - Rotation of the shell enhances mixing of solid wastes with the combustion air and provides for transport of the waste through the kiln. Most organic wastes, including solids, sludges, and slurries can be burned in rotary kilns. Destruction efficiencies of greater than 99% have been demonstrated. The equipment is transportable. The EPA has developed a transportable incineration system for on-site thermal destruction of hazardous materials at remote spill or disposal sites. This system can detoxify up to 2 tons per hour of contaminated dirt (about 15,000 tons per year) or up to 60 gallons per hour of liquid waste oil. Total project costs for on-site incineration range from $300 to $1000 per ton depending on waste characteristics. The equipment is commercially available.
  Most organic wastes, including solids, sludges, and slurries.
    Chlorinated organic compounds
  Contaminated soils
    liquid waste oil
    chlorinated wastes (e.g., dioxins)
    "pink water" or "red water"
    other explosives waste contamination

17 Fluidized Bed Incineration - The vessels contain a bed of graded, inert granular material, usually silica sand or a catalyst. The heated bed material is expanded by combustion air forced upward through the bed. As waste material is mixed with the hot fluidized bed material, heat is rapidly transferred back to the bed. Inorganic

materials in the waste stream are entrapped in the bed which necessitates continuous removal and make-up of bed material. Off-gas treatment follows a secondary combustion chamber. Fluidized bed incineration takes place at lower temperatures, pressures and with less oxygen than conventional incineration, while still maintaining destruction efficiencies of 99.99%. This technology is useful for destroying many species of waste in a variety of contaminated media; however, to be cost effective, the level of contamination should be relatively high. Operational costs compare favorably with other available types of incinerators.

Petroleum industry
Paper industry
Sewage disposal industry
Contaminated soils
PCBs

* Multiple Hearth - These furnaces can incinerate gases and liquids as well as sludges and solid wastes.
  Sewage sludges and municipal wastes

* Controlled Air Incineration (AKA Los Alamos Process) - Wastes enter the primary combustion chamber and are heated in an oxygen poor atmosphere. Off-gases then enter a secondary combustion chamber and are oxidized in an oxygen rich atmosphere. Exhaust gases are treated before being released.
  Organic wastes

* Cyclone Incinerator - A cylindrically shaped combustion chamber into which a mixture of fuel, waste, and air are introduced tangentially. The resulting high shear provides intense mixing and complete combustion. An additional fuel is required to maintain operation temperatures.
  Liquid organic wastes

* Molten Salts - Developmental - Wastes are incinerated in molten sodium carbonate. The heat destroys organic constituents while the salt traps inorganic contaminants and acts as a scrubber for off-gases and particulates. Treated wastes must have a low ash and low water content. Test results for specific molten salt reactors show destruction efficiencies of 99.9999% for chlorinated hydrocarbons. Pilot-plant testing of a molten salt reactor capable of destroying PCBs and other chlorinated hydrocarbon wastes and pesticides has been conducted.
  PCBs
  Other chlorinated hydrocarbons
  pesticides

Pyrolysis - This can be thought of a process of molecular fracturing as opposed to an oxidizing process like incineration.

18 Infrared Incinerators - Wastes are conveyed through a furnace on a woven metal conveyor belt; liquid wastes are passed through the furnace using pans placed on the conveyor belt. Test results on PCBs indicate destruction efficiencies of 99.9999% or better. Three firms are known to be developing infrared radiation reactors. Typical processing rates are 75 to 125 pounds of soil per minute. These reactors can be made

mobile for on-site remediation. A mobile unit with a capacity of 100 tons per day costs about $2.5 million.

PCBs
Dioxin
VOCs
Fuels

19 Plasma Arc Furnace - Waste material introduced into the reactor is melted to a slag by the intense heat of a plasma initiated by an electric arc between the torch and the reactor vessel. At plasma temperatures, organic molecules completely decompose to individual atoms. Off-gas is treated through conventional flue gas treatment systems to remove acid gases, particulate, and volatile metals prior to release to the atmosphere. The slag formed is discharged and allowed to solidify in waste disposal containers. The glassy slag binds hazardous materials such as toxic metals and radioactive isotopes, rendering them leach resistant. PAF is reported to be a technology capable of processing a wide variety of materials such as liquids, solids, slags, combustibles, and inerts. Because of large power consumption, it is best suited to concentrated wastes. Costs are dependent upon many parameters and may range from $200 to $1200/ton of material processed.

Organics
pesticides
wood preservatives
  PCP
  creosote
  petroleum compounds

OXIDATION

20 Wet Air Oxidation - This is the aqueous phase reaction of suspended organic substances and oxygen at elevated temperatures (175-750 C) and pressures (300-3000 psi). The process is well suited for waste streams that are too dilute to incinerate economically. This process destroys high concentrations of organic substances, making it both practical and economical to recover and reuse inorganic chemicals. Typically, aqueous waste streams containing 1-3% organic constituents by volume can be treated with this process. A catalyst may be added. The highly exothermic nature of this process makes the generation of by-product process steam or electrical power possible. Wet air oxidation has been known in the US for more than 30 years and has been specifically applied to industrial wastes. As regards aquifer remediation, this technology is primarily in the laboratory stage. One wet air oxidation unit reportedly treats cyanides, phenolics, sulfides, pesticides, solvent still bottoms, and general organics at a cost of from $0.50 to $2.00 per gallon.

Municipal wastewater
Soda pulping liquors at pulp mills
Sulfite liquors
N-Nitrosodimethylamine
Acrylonitrile wastes
Phenolics
Sulfides
Pesticides

carbaryl
dinoseb
methoxychlor
malathion
Solvent still bottoms
General organics
Cyanides

21 Supercritical Water Oxidation - Developmental - Similar to wet air oxidation, except that supercritical water at 375° C and 3210 psi is used as the reacting medium. The process is capable of treating waste streams that contain up to 20 vol% organic constituents. No NOx are produced because of the low oxidizing temperatures. Hydrocarbon removal of >99.99% is reported. One company estimates waste processing costs at $100 to $400 per thousand gallons of influent waste at organic concentrations of 0.08% to 3.0%. Supercritical water is less expensive to operate than many high temperature incinerators. This process can treat dilute organic or inorganic wastes which may be liquids, slurries, or sludges which may contain reactive:
ions
metals
inorganic salts
hydrocarbons
explosives

22 Ozonation - Ozone is a strong oxidizer for many organic compounds, excluding some halogenated organics. This technology is currently used at some waste water treatment facilities. Treatment with ozone is usually limited to waste streams with less than 1% oxidizable materials. It is particularly suited for destroying toxic organic compounds, especially chlorinated hydrocarbons in dilute concentrations in water. No residues, sludges or spent adsorbent materials are generated.
Organic groundwater contaminants
cyanides
phenols
dyes
TCE
perchloroethylene
methylene chloride
pesticides
PCBs
MEK

* Ultraviolet Light/Oxidation Treatment - Uses a strong oxidizing agent, hydrogen peroxide and/or ozone, in the presence of UV light to decontaminate aqueous waste streams containing hazardous organic compounds. The oxidant is added to the wastewater, which is then irradiated with UV light. The UV light converts the ozone and/or hydrogen peroxide into highly reactive hydroxyl radicals. Decontamination of the waste occurs when the organic contaminants react with the hydroxyl radicals to form nonhazardous compounds. Costs for one system utilizing UV/irradiation and hydrogen peroxide oxidation technology to treat groundwater containing

tetrahydrofuran, MEK, toluene, and cycloehexanone were $2.40 per 1000 gallons. Some systems are known to have serious maintenance problems.

Chlorinated hydrocarbons
- trichloroethylene
- perchloroethylene
- methylene chloride
- phenol
- plentachlorophenol

pesticides
tetrahydrofuran
MEK
toluene
cycloehexanone

23 CATALYTIC DECONTAMINATION (Dehalogenation, Dehydrochlorination)- The process replaces halogen (chlorine) atoms on the halogenated (chlorinated) compounds with hydrogen atoms with the use of an appropriate catalyst. This method can be useful when cross media transfer of the contamination that can occur in air stripping is unacceptable. It is especially applicable for highly contaminated waters such as leachates. It is primarily a groundwater restoration technique. Small-scale pilot testing has been conducted. Costs will probably be in the range of $1 to $8 per 1000 gallons, depending on the concentration of contaminants and the amount of pretreatment required.

VOCs

24 CHEMICAL DETOXIFICATION - The method, originally developed to
25 detoxify oil contaminated with PCBs, has been adapted to decontaminate soils. It is relatively inexpensive for contaminants at low concentrations in the ppm range. For high contaminant concentrations in the percent range, incineration could be less expensive. Some chlorinated compounds, such as hexachlorophene 24 are not degraded as effectively as others. The costs range from $100 to $200 per ton.

Dechlorination
- PCBs
- Dioxin in situ
- Herbicides
- Other chlorinated aromatic compounds

BIODEGRADATION - Biological treatment of waste involves the degradation of organic materials by microorganisms. Biodegradable compounds are typically of low or moderate molecular weight, and consequently volatile. Among the manmade compounds that prove biodegradable are many chlorinated and aromatic compounds. In some cases, the organisms accumulate material but do not degrade it. Biological treatment of soils contaminated with PCBs and explosives processing contamination is an active area of R&D. Many hazardous soil and groundwater contaminants, particularly petroleum derivatives, have been destroyed through the application of in situ biodegradation techniques. Biodegradation processes are generally inexpensive, low capital, selective processes, but are also relatively slow. Biological treatments generate sludge, the disposal of which can be a significant factor in the economics of a biological reactor. A disadvantage of biodegradation is the possibility of converting contaminants into more toxic compounds. For example, chlorinated organics like

trichloroethlyene can be degraded into more stable and much more toxic compounds like vinyl chloride. Several biodegradation systems are described below.

26 Composting - Used to decontaminate any soils or lagoon sludges containing explosives or propellants amenable to biodegradation. The process is simple and not energy or labor intensive. Expensive equipment is not required. Large-scale pilot projects have been conducted.

- Explosives
  - hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
  - 1,3,5,7-tetranitro-1,3,5,7-tetrazocyclooctane (HMX)
  - trinitrotoluene (TNT)
  - Tetryl
- Propellant
  - nitrocellulose

27 Land Farming - Land farming is a combination of several processes that serve to render the hazardous wastes less harmful to the environment. Hazardous waste is applied to the land as slurries, sludges, untreated wastes, residues or solid waste. Usually the wastes are applied to the top surface of land (0-1 foot) using conventional farming equipment and techniques. Chemical and biological reactions then break down a portion of the waste, a portion of the waste may be volatilized, adsorption and other immobilization processes occur over other portions, and controlled migration is allowed for certain anionic inorganic fractions of the waste. Substantially more effort in design and monitoring is required with this technology than with other more widely used or recognized technologies. The technical capability to manage virtually all types of wastes and the attractive economics make land farming viable in many situations. Presently there are about 200 hazardous waste land farming systems in the US and over 1000 such systems for nonhazardous industrial wastes.

- Industrial organic and inorganic compounds
- metals
- toxic compounds
- priority pollutants
- salts
- acids or bases
- pathogens
- large liquid volumes
- others

28 Aerobic Biodegradation - This technology is an early stage of
29 development. Can be used as an above-ground "pump and treat" method or could be used for in situ decontamination. Applications could include fuel spills, leaky storage tanks, and fire training pits. The method probably is not applicable for waste disposal pits. Biological degradation can be used in several different process, including activated sludge, aerated lagoons, trickling filters, rotating biological contactors, in situ processes, and land treatment processes. For in situ methods excavation is generally not required. The resulting products are not toxic. High Ca, Mg, or Fe concentrations in the soils limit the effectiveness of the method. Site characterization must be done to determine soil/chemical compatibility. Equipment and chemicals are commercially available. However, not much is known about the details of the process

in the field and the extent of site cleanup. For cleanup of lube oil spills at maintenance facilities, air strips, along roadways and streets, and parking lots, disking is required. Aerobic biodegradation can remove about 60% of waste oil. The application of biological treatment to groundwater treatment is restricted by the relatively low concentrations of organic matter usually found. The minimum concentration required for a biological treatment process is in the vicinity of 50 ppm biodegradable materials. The long time required to begin biological treatment renders the method unsuitable for short-term projects. Costs of from $100 to $200 per ton of contaminated soil have been estimated. Another estimate is that it would cost between $230 to $300 per gallon of fuel in the soil.

Trichloroethylene (developmental)
Fuels
Fuel oils
Lube oils
Nonhalogenated solvents.

IMMOBILIZATION - Immobilization technology encompasses a broad range of processes, each intended to physically immobilize hazardous wastes (both organic and inorganic, including radionuclides) and mitigate the chances for ground water contamination. Encapsulation/solidification processes can be applied in situ or more commonly using an extract-and-treat methodology. In either case the volume of hazardous wastes is increased. The basic technology required to implement the various immobilization processes is well developed. Typical costs range from $100 to $200 per cubic yard of soil. These costs do not reflect the costs of transportation to a permanent storage facility, if necessary.

* BITUMEN SOLIDIFICATION PROCESS - This process uses a high molecular weight hydrocarbon like bitumen or asphalt to encapsulate waste. Bitumen or asphalt occurs naturally or is obtained as a by-product of petroleum or coal-tar refining. The wastes and liquefied bitumen are fed into an extruder heated to approximately 215° C. The extruder mixes the waste and bitumen while evaporating the water. The mixture of waste and bitumen is poured into steel drums and the evaporated water is collected for additional treatment. Bitumen solidification is a commercially available process used in France, West Germany, Belgium, and Japan.

* POZZOLANIC PROCESSES - Fine-grained siliceous (pozzolanic) materials such as fly ash, ground furnace slag, and cement kiln dust can be mixed with lime and water to form a concrete-like solid when cured. This process is most commonly applied to inorganic wastes.

30 PORTLAND CEMENT - In this widely used solidification process, portland cement, water and a solid waste form (primarily inorganic wastes) are mixed together and allowed to harden. The strength and leach resistance of the final waste form varies widely depending on the final composition and numerous processing variables. Addition of portland cement is relatively inexpensive, but significantly increase the weight and volume of the final waste form .

* POLYMER ENCAPSULATION - Dried waste is either extruded with a thermoplastic or mixed with a thermo-setting plastic to form a solid waste form. This process is more tolerant of chemical changes in the waste stream than cementation processes and is

more efficient. Flammability of the organics is a concern. Commercially available equipment and materials are used .

31 IN SITU VITRIFICATION - Electrodes are placed in the contaminated
32 soils and high potentials are used to drive current through the soil. Resistive losses in the soil produces heat that vitrifies the glass-making components in the soil. Organic and some inorganic compounds are destroyed by pyrolysis. After cooling, the partially vitrified soil immobilizes the waste materials. Off-gases that occur during heating are collected and treated with appropriate systems. One company has developed a trailer-mounted in situ vitrification unit that is suitable for highway transport. Their system is capable of treating an area 27 ft. on a side to depths of 20 ft. Processing depths of up to 50 ft. are projected. This system has been demonstrated at full-scale on radioactive wastes at the DOE's Hanford Nuclear Reservation; pilot tests have also been conducted on PCB wastes, dioxins, and metal plating wastes, among others. Although very power intensive, its developers believe it can compete economically with alternative technologies. Estimated costs for soil vitrification range from $140 to $190 per cubic yard.

* GLASS MELTER - Traps inorganic and metallic constituents in a glass matrix while destroying the organic constituents. Organic liquids, dry sludges, and combustibles, are first mixed with glass formers and then introduced into the cavity of a glass melter. Electrical current is passed through electrodes protruding into the cavity. Resistance to the current generates the heat within the waste/glass mixture (joule heated; may also be gas or electrically heated). Off-gas treatment is required. The melted glass with the trapped ash is drawn into heated drums. After solidification, the drums are sealed, leak tested, and prepared for off-site shipment. This process reduces volume (approximately 10-30%) and creates a disposable waste form.

* MICROWAVE MELTER - Developmental - Similar to glass melter except the heating is done using microwave energy and in the shipping container. Organic substances, air and moisture are driven off, and metallic and organic substances are trapped in the glass matrix. Microwave melters may reduce the volume, up to 80%, for certain types of wastes. Off-gas treatment is required.

* GLASS-CERAMIC PROCESS - This developmental glass ceramic process vitrifies the waste in a joule heated glass melter. Similar to the normal glass melting process but the composition of the glass is adjusted slightly to have more alumina and less boron oxide. This allows a glass ceramic to be formed, which has a superior leach resistance and better thermal and mechanical shock resistance compared to borosilicate glass. After melting, the glass from the joule melter is placed into drums and cooled in a controlled-temperature cycle. After cooling, the drums are sealed, leak tested, and packed for storage.

* GLASS PELLETS IN INORGANIC BINDER - Laboratory-scale tests have been conducted at several facilities - Wastes are first incorporated in a glass matrix by melting in a joule heated glass melter. The molten glass is subsequently poured into a marble-making device or pelletized. The glass marbles or pellets are placed into a metal drum and further encapsulated in a cement or metal matrix. The drum is then

sealed, welded, checked and placed into storage. The total waste loading for this waste form is 4 wt%.

* SUPERCALCINE HOT-ISOSTATIC PRESSING - This process is in the laboratory stage of development - Supercalcine is a silicate-based material produced by calcining the oxides of silicon and the nitrates of calcium, aluminum, and strontium. These components are combined in carefully defined proportions, so that during calcination they will react with the components of radioactive waste to form stable apatite, fluorite, sheelite, pollucite, and spinel crystal structures. This waste form is packed into drums for storage.

* SYNROC HOT-ISOSTATIC PRESSING - This process is in the laboratory stage of development - This is a series of synthetic, igneous rock systems consisting of a combination of thermodynamically compatible minerals. The selected minerals are known to have the capacity to accept and to retain radioactive waste elements in their crystal lattices.

* TITANATE PROCESS - Laboratory stage of development - This process produces a titanate-ceramic waste product. The titanate monolith is expected to have an oxide waste loading of 25 wt% and a density of 4 kg/l.

* CERMET PROCESS - Laboratory stage of development - Cermet is a composite material containing fine ceramic particles dispersed in a leach-resistant, metallic phase. Waste species, such as iron and nickel, that can be reduced to the metallic state by carbon monoxide or hydrogen are incorporated into the metallic phase as an alloy. The dispersed ceramic phase can be tailored using chemical additions chosen to confine nonreducible waste, radioactive actinide nuclides, and other heavy metals. This process requires feed material of soluble species or slurries.

* FUTAP CONCRETE PROCESS - This is an elevated temperature and pressure concrete process. The feed material could be liquids, powdered solids, or slurries. In a batch process, the feed material is combined with water, cement, fly ash, and illitic clay in a mixer. The drum of concrete must be air dried for an extended period of time (years) to allow the free water in the concrete to evaporate. The drum is then prepared for storage. The oxide waste loading is approx. 19 wt% and has a density of 1.7 kg/l.

APPENDIX D

TESTING OF THE

HAZARDOUS WASTE SITE ANALYSIS

Site Classification and Remediation Methodology

TESTING OF THE HAZARDOUS WASTE SITE ANALYSIS Site Classification and Remediation Methodology

INTRODUCTION

The development of the **HAZARDOUS WASTE SITE ANALYSIS Site Classification and Remediation Methodology** (a.k.a., waste site analyzer) is not complete until it has been tested. The purpose of this document is to report the results of such testing. The following test cases were based upon the report entitled, *Reassessment of Sierra Army Depot, Herlong, Calif., Report No 149R,* dated September 1983. This report was used to test the effectiveness of the waste site analyzer, in lieu of conducting an actual on-site investigation. This referenced report was provided to the authors by USATHAMA for testing purposes.

In the referenced report, it states that 34 areas were investigated at the Sierra Army Depot (SIAD) in Herlong CA. These areas were no longer in use at the time of the investigation. The conclusions of the report were that only 5 of the 34 areas were determined to have the potential for contaminant migration. The other 29 areas were classified as having no such potential and thus were eliminated from this testing of the waste site analyzer. This is because these 29 sites would undoubtedly get ranked as "Small Sites", which would not offer a real test of the effectiveness of the waste site analyzer.

The 5 areas with the potential for contaminant migration were subjected to the logic of the waste site analyzer to see if (1) the sites are "Small Sites" and (2) if not, what treatment would be recommended. The 5 areas were designated:

- CSL Area 11 (Firefighting Training Pit)
- CSL Area 20 (Active Popping Plant & Inactive Leaching Beds)
- CSL Area 21 (Dump and Fill Area - Abandoned Landfill)
- CSL Area 24 (Lower Burning/Demolition Grounds)
- DPDO Trenches (Undesignated by CSL)

CSL means Chemical Systems Laboratory. DPDO stands for Defense Property Disposal Office.

During the early development of the waste site analyzer, 6 primary discriminators were chosen. These discriminators, which should distinguish one waste site from another, were:

- Risk to Public
- Setting of the Site
- Uncontrolled Releases
- Federal Laws and Regulations
- Societal and Political Issues
- Estimated cost of remediation

Associated with each primary discriminator was a set of two or more questions of logic. Both the primary discriminators and the questions of logic were then placed on the decision tree, **Fig A-1 DECISION TREE FOR CLASSIFYING WASTE SITES**. In the following tables, both the primary discriminators and questions of logic are repeated verbatim, along with answers. There is one table for each of the 5 waste sites.

The questions of logic are shown in the left-hand column, along with the possible weighting factors that may be assigned. The middle column shows the weighting factors that were actually assigned, based upon available information about the particular site. Again, this information was taken from the referenced report, in lieu of conducting an actual on-site investigation. The column on the right gives references in the report that lead to the Assigned Weighting Factors shown in the middle column. The primary rules of the waste site analyzer are:

1. To be classified as a "Small Site", the total of the weighting factors for each primary discriminator must be less than 20.

2. If the total weighting factors for any one or more of the primary discriminators is equal to or greater than 20, the site is not a "Small Site".

For more information on the meanings of the weighting factors, see "Discussion of Weighting Factors", which starts on page 10 of the waste site analyzer report.

It was decided early in the testing phase that we would not change the current logic, or weighting factors, based upon the results of early testing. Instead, we decided to present the test results and discuss any weaknesses that were discovered.

METHODOLOGY TEST I

CSL AREA 11 (FIREFIGHTING TRAINING PIT)

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS

Determine (below) if Site Poses an Imminent Health Risk to Public

A1. Do Waste Constituents in Soil Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	15
Moderately High Concentrations	8
Low Concentrations	2

Assigned Weighting Factor: 2

Comments: Pages 2-23 and 2-24 state that the contaminants are diesel fuel, gasoline, and waste oils that were ignited on the surface of the ground. The affected area is 12 m in diameter and the oily residue extends to at least 15 to 20 cm deep. Most of the highly volatile components would have burned off during the training exercise leaving the less mobile heavier components.

A2. Do Waste Constituents in Ground Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	15
Moderately High Concentrations	8
Low Concentrations	2

Assigned Weighting Factor: 2

Comments: There is no evidence that waste constituents are in the ground water. Pages 2-23 and 2-24 state that the water table is expected to be 40 m below the surface. The total depth of penetration of the hydrocarbons is unknown, except for the visible oil residue that extends to at least 15 to 20 cm deep. The pit is located on sandy loam which has a moderate infiltration characteristic.

A3. Do Waste Constituents in Surface Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	20
Moderately High Concentrations	10
Low Concentrations	5

Assigned Weighting Factor: 5

Comments: Page 2-24 states that there is no potential for surface contamination migration. This is because of the arid climate and the fact that most of the contaminants are in the soil as opposed to on the soil. The chances for erosion are quite small.

A4. Do Waste Constituents in Air Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	20
Moderately High Concentrations	10
Low Concentrations	5

Assigned Weighting Factor: 5

Comments: Page 2-24 says that there is no potential for airborne contamination migration.

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION: 14

CONCLUSION: From this set of questions on imminent health risk to the public, the site ranks as a "Small Site".

Determine (below) the Physical Setting of the Site

B1. Is Site in Close Proximity to Ground Water Supplies that are Used for Domestic or Agricultural Purposes?

Distance	Factors
30 ft (9 m) or Less	15
30 ft (9 m) to 100 ft (30 m)	10
100 ft (30 m) to 300 ft (90 m)	5
Greater than 300 ft (90 m)	1

Assigned Weighting Factor: 1

Comments: Pages 1-5 and 1-20 indicate that CSL Area 11 is approximately 1200 m (4500 ft) from the nearest well, Well 5. The water table is expected to be 40+ m below the surface. The drawdown of the groundwater between CSL Area 11 and Well 5 is estimated to be about 2 m, assuming a transmissivity of 620 sq m per day (Page E-2). Water is extracted from the wells at 110 to 180 m below the surface (Page 1-19). The nearest agricultural area is at least 15,000 m from CSL Area 11.

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
B2. Is Site in Close Proximity to Surface Water Supplies that are Used for Domestic or Agricultural Purposes? Distance — Factors 300 ft (90 m) or Less — 15 300 ft (90 m) to 1000 ft (300 m) — 10 1000 ft (300 m) to 3000 ft (900 m) — 5 Greater than 3000 ft (900 m) — 1	1	Page 1-20 shows the location of the potable water sources for the SIAD, including the town of Herlong These sources are four water well, Wells 2, 5, 8, and 9 No surface water is used for domestic purposes The distance from CSL Area 11 to the nearest water well that is used for agricultural purposes is approximately 15,000 m upgradient
B3. Is Waste in a Secure Containment(s)? Factors Uncontrolled — 15 Lined/Diked Pit, Trench, or Pad — 8 In Sealed Containers — 2	15	Pages 2-23 and 2-24 say that the contaminants were deliberately poured on the ground for training fire fighters
B4. Is Access to Site Controlled? Factors Uncontrolled — 15 Limited Area with Fence — 8 Fenced and Guarded — 2	2	The site is on a military post that has guarded entries by the Military Police (Page 2-11)
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	19	**CONCLUSION: From this set of questions on physical setting, the site ranks as a "Small Site".**

Determine (below) If Site Is Subject to Rapid, Uncontrolled Releases to Biosphere

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
C1. Are Waste Forms Combustible? Factors Explosive or Spontaneous — 20 Moderate to High Combustibility — 15 Low Combustibility — 5 Noncombustible — 0	0	Page 2-24 states that the materials which were obviously combustible when first poured on the ground had penetrated the ground Experience indicates that the materials cannot burn
C2. Is Waste Subject to Flooding? Factors High Probability — 15 Moderate Probability — 10 Low Probability — 5	5	Page 1-17 states that "The lack of surface drainage features in this area is a result of low precipitation, lack of topographic relief, and soil conditions"
C3. Is Waste Subject to Wind/Weather Damage or Dispersal (tornadoes, hurricanes, wind storms lightning, etc)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	2	Page 2-24 says that there is no potential for airborne contamination migration
C4. Is Waste Site Subject to Other Natural/Manmade Disasters or Disturbances that could Damage or Disperse Waste Forms (earthquakes, forest fires, artillery impacts, etc)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	5	The greatest potential for such problems is associated with the explosives work, however, that is the purpose of this installation The explosives activities are not spontaneous but rather are controlled
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	12	**CONCLUSION: From this set of questions on rapid and uncontrolled releases to the biosphere, the site ranks as a "Small Site".**

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS

Select Applicable Federal Laws and Regulations That Must be Complied With (see *Appendix B*)

D1. Do Federal Regulations Require Early or Immediate Remedial Action?

	Factors
Immediate Environ Remediation	20
Immediate Interim Action	10
Eventual Environ Remediation	5

Assigned weighting factor: 5

Comments: To our knowledge, no such regulations exist

D2. Can Site be Permanently Closed Without Remediation?

	Factors
Yes	20
No	0

Assigned weighting factor: 0

Comments: The site probably should be remediated, especially if and when SIAD is decommissioned

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION — 5

CONCLUSION: From this set of questions on applicable federal laws and regulations, the site ranks as a "Small Site".

Determine (below) If Site Is a Major Societal or Political Issue

E1. Are There Any Major Local (or Regional) Societal or Political Issues?

	Factors
Considerable Press/Media Coverage	20
Some Press/Media Coverage	10
No Press/Media Coverage	0

Assigned weighting factor: 0

Comments: Although the report does not address this, it is fairly safe to assume that there are no major societal or political issues. Most all the people in Herlong and the surrounding area, except those involved in agriculture, make their living either directly or indirectly at SIAD

E2. Is There Likelihood of Societal or Political Issues Before Scheduled Remediation?

	Factors
Very High Probability	8
High Probability	6
Moderate Probability	4
Low Probability	3
Negligible Probability	0

Assigned weighting factor: 0

Comments: Again, this is not addressed in the report, but for the same reason cited in Question E1 above, it is unlikely that any major societal or political issues will be raised

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION — 0

CONCLUSION: From this set of questions on major societal or political issues, the site ranks as a "Small Site".

Determine (below) the Estimated Costs to Remediate Site

F1. What is Estimated Cost of Site Characterization?

	Factors
Greater Than $1.5M	20
$1.0M to $1.5M	14
$.5M to $1.0M	7
Less Than $.5M	0

Assigned weighting factor: 0

Comments: Page 2-24 states that the visible residue covers an area 12 m in diameter and goes down to 15 to 20 cm. The only unknown part of the problem is the extent of the nonvisible hydrocarbons

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
F2. What is Estimated Cost of Waste Treatment?	0	The soil could probably be excavated, incinerated and replaced in the ground. If not, it could be excavated, transported and buried at a more suitable location, preferably in a lined and capped trench.
F3. What is Estimated Cost of Site Closure & Monitoring?	0	Assuming the site can be remediated as shown in Question F2, the cost of closure would be very minimal and site monitoring would not be required.

F2 factors:

	Factors
Greater Than \$1.5M	20
\$1.0M to \$1.5M	14
\$.5M to \$1.0M	7
Less Than \$.5M	0

F3 factors:

	Factors
Greater Than \$1.5M	20
\$1.0M to \$1.5M	14
\$.5M to \$1.0M	7
Less Than \$.5M	0

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION: 0

CONCLUSION: From this set of questions on estimated costs for remediation, the site ranks as a "Small Site".

FINAL CONCLUSION: Because none of the previous conclusions on this site, CSL Area 11, concluded otherwise, this site is ranked as a "Small Site". This is considered to be the "First Iteration thru the Logic" (see Fig A-1 at the entry point to the Site Remediation section). If further investigation is desired, or required, in the future, a detailed site characterization (RI/FS) should be conducted. At the conclusion of the detailed site characterization, a second iteration should be made through the logic above to see if the classification changes.

RANKING AGAINST OTHER SITES: For purposes of ranking this site against the other sites being tested, this site has a total ranking of 50. That is,

A1 thru A4	=	14
B1 thru B4	=	19
C1 thru C4	=	12
D1 thru D2	=	5
E1 thru E2	=	0
F1 thru F3	=	0
		50

Site Remediation for CSL Area 11 (Firefighting Training Pit)

The site has now been classified. According to the decision tree (Fig. A-1), a detailed site characterization should now be performed. For testing purposes, this is impractical because on-site environmental work is only being simulated by the information in the report entitled, *Reassessment of Sierra Army Depot, Herlong, Calif., Report No 149R*. However, we will accept the limited contaminant information in the report and continue testing. Also, we will assume that remediation will be done, when in fact, it may not be necessary.

Continuing through the logic of Fig. A-1, we are directed to Appendix C. Here, we use Fig. C-1, *Procedure for Selection of Possible Treatments* and Table C-1, *Treatment Selection Table*. According to Fig. C-1 we are to assign a *Contaminant* code, a *Soil* code, and a *Contaminated Medium and Environment* code for each contaminant. The report stated that CSL Area 11 contains diesel fuel, gasoline, and waste oils that were ignited on the surface of the unsaturated ground. Diesel fuel and gasoline are fuels, coded "F". Waste oils are coded "O" for non-volatile organics. The soil is described in the report as sandy, which would be coded as "I". Also, the contaminated medium would be coded "Su". Therefore, the treatment identifier table, per Fig. C-1, would appear as:

	TREATMENT IDENTIFIER		
	1st field	2nd field	3rd field
Diesel Fuel	F	I	Su
Gasoline	F	I	Su
Waste Oils	O	I	Su

After the process of deletion, as described in Fig. C-1, the LISTS OF TREATMENT NUMBERS look like:

Diesel Fuel

LIST OF TREATMENT NUMBERS		
F	F + I	F + I + Su
1	1	1
2		
3		
4	4	4
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
21		
22		
23		
27		
28		
29	29	29

Gasoline

LIST OF TREATMENT NUMBERS		
F	F + I	F + I + Su
1	1	1
2		
3		
4	4	4
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
21		
22		
23		
27		
28		
29	29	29

Waste Oils

LIST OF TREATMENT NUMBERS		
O	O + I	O + I + Su
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
26		

Fortunately, Treatments 6 and 10 are common for all three contaminants. Therefore, Steam Stripping (in situ) (**6**), and Soil Washing (in situ) (**10**), are recommended. The final choice would be determined by

economics, available skills, available equipment, etc. The extracted and concentrated materials would then have to be disposed of, probably by incineration.

Bear in mind, that the Possible Treatments shown on Table C-1 are the currently demonstrated treatments at the time of publication. Other treatments are, and will be, in development.

METHODOLOGY TEST II

CSL AREA 20 (ACTIVE POPPING PLANT AND INACTIVE LEACHING BEDS)

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS

Determine (below) If Site Poses an Imminent Health Risk to Public

A1. Do Waste Constituents in Soil Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	15
Moderately High Concentrations	8
Low Concentrations	2

Assigned weighting factor: 2

Pages 2-25 and 2-26 state that the operations involved ferrous and nonferrous metal scraps, including lead, resulting from dismantling of small munitions. Also present are TNT and DNT that resulted from shell washout operations prior to 1959. The popping plant is still in use but the leaching beds are not since 1959. Since the plant was built, all recovered metals have been salvaged and reused. However, until 1979 the operation had no air emission controls so metal and explosive contaminants were lost to the ground immediately around the plant. Prior to 1959 TNT and DNT were sluiced into two unlined leaching trenches that measured 7.6 m by 9.1 m and 9.1 m by 12.2 m, respectively. The explosives are visible as a pink stain on the sand.

A2. Do Waste Constituents in Ground Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	15
Moderately High Concentrations	8
Low Concentrations	2

Assigned weighting factor: 2

There is no evidence that waste constituents are in the ground water. Page 2-26 states that the water table is expected to be 40 m below the surface. "The metallic particulates are not a source of ground water contamination because subsoils are strongly calcareous and slightly basic (USSCS, 1968), thereby, greatly restricting mobility of the metals." The explosives in the leaching bed are a potential source of contamination to the ground water 40 m or less below.

A3. Do Waste Constituents in Surface Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	20
Moderately High Concentrations	10
Low Concentrations	5

Assigned weighting factor: 5

Page 2-26 states that there is no potential for surface contamination migration.

A4. Do Waste Constituents in Air Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	20
Moderately High Concentrations	10
Low Concentrations	5

Assigned weighting factor: 5

Page 2-26 says that there is no potential for airborne contamination migration.

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION: 14

CONCLUSION: From this set of questions on imminent health risk to the public, the site ranks as a "Small Site".

Determine (below) the Physical Setting of the Site

B1. Is Site in Close Proximity to Ground Water Supplies that are Used for Domestic or Agricultural Purposes?

Distance	Factors
30 ft (9 m) or Less	15
30 ft (9 m) to 100 ft (30 m)	10
100 ft (30 m) to 300 ft (90 m)	5
Greater than 300 ft (90 m)	1

Assigned weighting factor: 1

Pages 1-5 and 1-20 indicate that CSL Area 20 is approximately 2700 m (8800 ft) from the nearest wells, Wells 2 and 8. The water table is expected to be 40+ m below the surface. The drawdown of the groundwater between CSL Area 20 and Wells 2 and 8 is estimated to be about 6 m, assuming a transmissivity of 620 sq m per day (Page E-2). Water is extracted from the wells at 110 to 180 m below the surface (Page 1-19). The nearest agricultural area is at least 11,000 m from CSL Area 20.

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
B2. Is Site in Close Proximity to Surface Water Supplies that are Used for Domestic or Agricultural Purposes? Distance — Factors 300 ft (90 m) or Less — 15 300 ft (90 m) to 1000 ft (300 m) — 10 1000 ft (300 m) to 3000 ft (900 m) — 5 Greater than 3000 ft (900 m) — 1	1	Page 1-20 shows the location of the potable water sources for the SIAD, including the town of Herlong. These sources are four water well, Wells 2, 5, 8, and 9. No surface water is used for domestic purposes. The distance from CSL Area 20 to the nearest water well that is used for agricultural purposes is approximately 11,000 m upgradient
B3. Is Waste in a Secure Containment(s)? Factors Uncontrolled — 15 Lined/Diked Pit, Trench, or Pad — 8 In Sealed Containers — 2	15	Pages 2-25 and 2-26 say that the contaminants were allowed to exit the plant via the ventilation system or were poured into the leaching pit
B4. Is Access to Site Controlled? Factors Uncontrolled — 15 Limited Area with Fence — 8 Fenced and Guarded — 2	2	The site is on a military post that has guarded entries by the Military Police (Page 2-11)
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	19	**CONCLUSION: From this set of questions on physical setting, the site ranks as a "Small Site".**

Determine (below) If Site Is Subject to Rapid, Uncontrolled Releases to Biosphere

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
C1. Are Waste Forms Combustible? Factors Explosive or Spontaneous — 20 Moderate to High Combustibility — 15 Low Combustibility — 5 Noncombustible — 0	5	Page 2-25 implies that the explosives, which are visible as a p[illegible] stain on the sand, might be combustible. Of course the metal contamination on the ground (from the plant ventilation system) is noncombustible
C2. Is Waste Subject to Flooding? Factors High Probability — 15 Moderate Probability — 10 Low Probability — 5	5	Page 1-17 states that "The lack of surface drainage features in this area is a result of low precipitation, lack of topographic relief, and soil conditions." Page 2-26 essentially says the same
C3. Is Waste Subject to Wind/Weather Damage or Dispersal (tornadoes, hurricanes, wind storms, lightning, etc.)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	2	Page 2-26 says that there is no potential for airborne contamination migration
C4. Is Waste Site Subject to Other Natural/Manmade Disasters or Disturbances that could Damage or Disperse Waste Forms (earthquakes, forest fires, artillery impacts, etc.)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	2	The greatest potential for such problems is associated with the explosives work, however, that is the purpose of this installation. The explosives activities are not spontaneous but rather are controlled
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	14	**CONCLUSION: From this set of questions on rapid and uncontrolled releases to the biosphere, the site ranks as a "Small Site".**

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
<u>Select Applicable Federal Laws and Regulations That Must be Complied With (see *Appendix B*)</u>		
D 1. Do Federal Regulations Require Early or Immediate Remedial Action? Factors Immediate Environ. Remediation 20 Immediate Interim Action 10 Eventual Environ. Remediation 5	5	To our knowledge, no such regulations exist
D 2. Can Site be Permanently Closed Without Remediation? Factors Yes 20 No 0	0	The site probably should be remediated, especially if and when SIAD is decommissioned
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	5	**CONCLUSION: From this set of questions on applicable federal laws and regulations, the site ranks as a "Small Site".**
<u>Determine (below) If Site Is a Major Societal or Political Issue</u>		
E 1. Are There Any Major Local (or Regional) Societal or Political Issues? Factors Considerable Press/Media Coverage 20 Some Press/Media Coverage 10 No Press/Media Coverage 0	0	Although the report does not address this, it is fairly safe to assume that there are no major societal or political issues. Most all the people in Herlong and the surrounding area, except those involved in agriculture, make their living either directly or indirectly at SIAD.
E 2. Is There Likelihood of Societal or Political Issues Before Scheduled Remediation? Factors Very High Probability 8 High Probability 6 Moderate Probability 4 Low Probability 3 Negligible Probability 0	0	Again, this is not addressed in the report, but for the same reason cited in Question E1 above, it is unlikely that any major societal or political issues will be raised
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	0	**CONCLUSION: From this set of questions on major societal or political issues, the site ranks as a "Small Site".**
<u>Determine (below) the Estimated Costs to Remediate Site</u>		
F 1. What is Estimated Cost of Site Characterization? Factors Greater Than $1.5M 20 $1.0M to $1.5M 14 $.5M to $1.0M 7 Less Than $.5M 0	7	Page 2-26 states that there is a visible pink stain in the leaching pits and on the concrete trench leading to the pits. The depth of leaching of explosives from the pits is unknown but the ground has a high infiltration rate and there were large quantities of water used during the shell washout operations.

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
F2. What is Estimated Cost of Waste Treatment? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	7	The soil could probably be excavated, incinerated and replaced on the ground
F3. What is Estimated Cost of Site Closure & Monitoring? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	0	Assuming the site can be remediated as shown in Question F2 the cost of closure would be very minimal and site monitoring would not be required.
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	14	CONCLUSION: From this set of questions on estimated costs for remediation, the site ranks as a "Small Site".

FINAL CONCLUSION: Because none of the previous conclusions on this site, CSL Area 20, concluded otherwise, this site is ranked as a "Small Site". This is considered to be the "First Iteration thru the Logic" (see Fig A-1 at the entry point to the Site Remediation section). If further investigation is desired, or required, in the future, a detailed site characterization (RI/FS) should be conducted. At the conclusion of the detailed site characterization, a second iteration should be made through the logic above to see if the classification changes.

RANKING AGAINST OTHER SITES: For purposes of ranking this site against the other sites being tested, this site has a total ranking of 66. That is,

A1 thru A4	=	14
B1 thru B4	=	19
C1 thru C4	=	14
D1 thru D2	=	5
E1 thru E2	=	0
F1 thru F3	=	14
		66

Site Remediation for CSL Area 20 (Active Popping Plant and Inactive Leaching Beds)

The site has now been classified. According to the decision tree (Fig. A-1), a detailed site characterization should now be performed. For testing purposes, this is impractical because on-site environmental work is only being simulated by the information in the report entitled, *Reassessment of Sierra Army Depot, Herlong, Calif., Report No 149R*. However, we will accept the limited contaminant information in the report and continue testing. Also, we will assume that remediation will be done, when in fact, it may not be necessary.

Continuing through the logic of Fig. A-1, we are directed to Appendix C. Here, we use Fig. C-1, *Procedure for Selection of Possible Treatments* and Table C-1, *Treatment Selection Table.* According to Fig. C-1 we are to assign a *Contaminant* code, a *Soil* code, and a *Contaminated Medium and Environment* code for each contaminant. The report stated that CSL Area 20 contains ferrous and nonferrous metal scraps, including lead, resulting from dismantling of small munitions. Also present are TNT and DNT that resulted from shell washout operations prior to 1959. Ferrous and nonferrous metals are coded "M". TNT and DNT are coded "X" for explosives. The contaminants originally came from either an exhaust stack or a water discharge pipe. The soil is described in the report as sandy, which would be coded as "I". Also, the contaminated medium would be coded "Su". Therefore, the treatment identifier table, per Fig. C-1, would appear as:

	TREATMENT IDENTIFIER		
	1st field	2nd field	3rd field
Ferrous & Nonferrous Metals	M	I	Su
TNT & DNT	X	I	Su

After the process of deletion, as described in Fig. C-1, the LISTS OF TREATMENT NUMBERS look like:

Ferrous & Nonferrous Metals

LIST OF TREATMENT NUMBERS		
M	M + I	M + I + Su
8		
9		
10	10	10
11		
12		
13		
15		
16		
17		
18		
19		
20		
21		
30		
31		
32	32	32

TNT & DNT

LIST OF TREATMENT NUMBERS		
X	X + I	X + I + Su
8		
9		
10	10	10
13		
16		
17		
18		
19		
20		
21		
26		
28		
29	29	29

Fortunately, Treatment 10 is common for all contaminants. Therefore Soil Washing (in situ) (**10**), is recommended. The final choice would be determined by economics, available skills, available equipment, etc. The extracted and concentrated materials would then have to be disposed of, probably by incineration of the explosives and recycling of the metals.

Bear in mind, that the Possible Treatments shown on Table C-1 are the currently demonstrated treatments at the time of publication. Other treatments are, and will be, in development.

METHODOLOGY TEST III

CSL AREA 21 (DUMP AND FILL AREA - ABANDONED DUMP)

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS

Determine (below) If Site Poses an Imminent Health Risk to Public

A1. Do Waste Constituents in Soil Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	15
Moderately High Concentrations	8
Low Concentrations	2

Assigned weighting factor: 8

Page 2-26 states that the contaminants are unknown quantities of a wide variety of materials (including paint sludges, paint thinners, solvents, cleaning fluids and waste oil). The area was used for a burn-and-bury operation for approximately 20 years; however, nothing was said in the report about the size of the area. Without further site characterization, it can only be assumed that this area is similar to many municipal waste areas. It is probably not the dump site for massive quantities of hazardous industrial wastes.

A2. Do Waste Constituents in Ground Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	15
Moderately High Concentrations	8
Low Concentrations	2

Assigned weighting factor: 2

There is no evidence that the constituents have reached the water table. Page 2-27 states that the water table is expected to be 40 m below the surface. The area is located on sandy loam which has a high infiltration characteristic.

A3. Do Waste Constituents in Surface Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	20
Moderately High Concentrations	10
Low Concentrations	5

Assigned weighting factor: 5

There appears to be little to no potential for surface contamination migration. This is because of (1) the arid climate and (2) the fact that most of the contaminants are under the soil overburden as opposed to on the top of the soil. The chances for erosion are quite small.

A4. Do Waste Constituents in Air Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?

	Factors
Very High Concentrations	20
Moderately High Concentrations	10
Low Concentrations	5

Assigned weighting factor: 5

Because the area is an abandoned dump and presumably covered, there is no potential for airborne contamination migration.

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION: 20

CONCLUSION: From this set of questions on imminent health risk to the public, the site does not rank as a "Small Site".

Determine (below) the Physical Setting of the Site

B1. Is Site in Close Proximity to Ground Water Supplies that are Used for Domestic or Agricultural Purposes?

Distance	Factors
30 ft (9 m) or Less	15
30 ft (9 m) to 100 ft (30 m)	10
100 ft (30 m) to 300 ft (90 m)	5
Greater than 300 ft (90 m)	1

Assigned weighting factor: 1

Pages 1-5 and 1-20 indicate that CSL Area 21 is approximately 800 m (2600 ft) from the nearest wells, Wells 2 and 8. The water table is expected to be 40+ m below the surface. The drawdown of the groundwater between CSL Area 21 and Wells 2 and 8 is estimated to be about 1 m, assuming a transmissivity of 620 sq m per day (Page E-2). Water is extracted from the wells at 110 to 180 m below the surface (Page 1-19). The nearest agricultural area is at least 14,000 m from CSL Area 21.

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
B2. Is Site in Close Proximity to Surface Water Supplies that are Used for Domestic or Agricultural Purposes? Distance / Factors 300 ft (90 m) or Less — 15 300 ft (90 m) to 1000 ft (300 m) — 10 1000 ft (300 m) to 3000 ft (900 m) — 5 Greater than 3000 ft (900 m) — 1	1	Page 1-20 shows the location of the potable water sources for the SIAD, including the town of Herlong. These sources are four water well, Wells 2, 5, 8, and 9. No surface water is used for domestic purposes. The distance from CSL Area 21 to the nearest water well that is used for agricultural purposes is approximately 14,000 m upgradient.
B3. Is Waste in a Secure Containment(s)? Factors Uncontrolled — 15 Lined Diked Pit, Trench, or Pad — 8 in Sealed Containers — 2	15	Page 2-26 says that the contaminants resulted from a burn and bury operation.
B4. Is Access to Site Controlled? Factors Uncontrolled — 15 Limited Area with Fence — 8 Fenced and Guarded — 2	2	The site is on a military post that has guarded entries by the Military Police (Page 2-11).
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	19	***CONCLUSION: From this set of questions on physical setting, the site ranks as a "Small Site".***

Determine (below) If Site Is Subject to Rapid, Uncontrolled Releases to Biosphere

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
C1. Are Waste Forms Combustible? Factors Explosive or Spontaneous — 20 Moderate to High Combustibility — 15 Low Combustibility — 5 Noncombustible — 0	0	Although the report does not state exactly, pages 2-26 and 2-27 imply that the abandoned dump has been backfilled. This would mean no combustion. Page 2-26 makes a distinction between this area and the burning/demolition areas for explosives.
C2. Is Waste Subject to Flooding? Factors High Probability — 15 Moderate Probability — 10 Low Probability — 5	5	Page 1-17 states that "The lack of surface drainage features in this area is a result of low precipitation, lack of topographic relief, and soil conditions."
C3. Is Waste Subject to Wind/Weather Damage or Dispersal (tornadoes, hurricanes, wind storms, lightning, etc.)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	2	Because the area is presumably backfilled, there is no potential for airborne contamination migration.
C4. Is Waste Site Subject to Other Natural/Manmade Disasters or Disturbances that could Damage or Disperse Waste Forms (earthquakes, forest fires, artillery impacts, etc.)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	5	The greatest potential for such problems is associated with the explosives work, however, that is the purpose of this installation. The explosives activities are not spontaneous but rather are controlled.
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	12	**CONCLUSION: From this set of questions on rapid and uncontrolled releases to the biosphere, the site ranks as a "Small Site".**

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
Select Applicable Federal Laws and Regulations That Must be Complied With (see *Appendix B*)		
D 1. Do Federal Regulations Require Early or Immediate Remedial Action? Factors Immediate Environ. Remediation 20 Immediate Interim Action 10 Eventual Environ. Remediation 5	5	To our knowledge, no such regulations exist
D 2. Can Site be Permanently Closed Without Remediation? Factors Yes 20 No 0	0	The site probably should be considered for remediation especially, if and when SIAD is decommissioned
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	5	CONCLUSION: **From this set of questions on applicable federal laws and regulations, the site ranks as a "Small Site".**
Determine (below) If Site Is a Major Societal or Political Issue		
E 1. Are There Any Major Local (or Regional) Societal or Political Issues? Factors Considerable Press/Media Coverage 20 Some Press/Media Coverage 10 No Press/Media Coverage 0	0	Although the report does not address this it is fairly safe to assume that there are no major societal or political issues. Most all the people in Herlong and the surrounding area, except those involved in agriculture, make their living either directly or indirectly at SIAD
E 2. Is There Likelihood of Societal or Political Issues Before Scheduled Remediation? Factors Very High Probability 8 High Probability 6 Moderate Probability 4 Low Probability 3 Negligible Probability 0	0	Again, this is not addressed in the report, but for the same reasons cited in Question E1 above, it is unlikely that any major societal or political issues will be raised
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	0	CONCLUSION: **From this set of questions on major societal or political issues, the site ranks as a "Small Site".**
Determine (below) the Estimated Costs to Remediate Site		
F 1. What is Estimated Cost of Site Characterization? Factors Greater Than \$1.5M 20 \$1.0M to \$1.5M 14 \$.5M to \$1.0M 7 Less Than \$.5M 0	0	Most of the site characterization has already been done

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
F2. What is Estimated Cost of Waste Treatment? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	0	The responsible people at SIAD probably already feel that the site has been remediated when it was assumedly backfilled.
F3. What is Estimated Cost of Site Closure & Monitoring? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	0	Assuming the site has been remediated as shown in Question F2 the cost of closure would be very minimal but site monitoring would be required.
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	0	**CONCLUSION: From this set of questions on estimated costs for remediation, the site ranks as a "Small Site".**

FINAL CONCLUSION: Because Section A [Determine (below) If Site Poses an Imminent Health Risk to Public] scored 20 points, this site, CSL Area 21, is not ranked as a "Small Site". This is considered to be the "First Iteration thru the Logic" (see Fig A-1 at the entry point to the Site Remediation section). According to the logic of the "Waste Site Classifier", a detailed site characterization (RI/FS) should be conducted. At the conclusion of the detailed site characterization, a second iteration should be made through the logic above to see if the classification changes. (See "Conclusions on Testing of Waste Site Classifier" for more information on this site ranking.)

RANKING AGAINST OTHER SITES: For purposes of ranking this site against the other sites being tested, this site has a total ranking of 56. That is,

A1 thru A4	=	20
B1 thru B4	=	19
C1 thru C4	=	12
D1 thru D2	=	5
E1 thru E2	=	0
F1 thru F3	=	0
		56

Site Remediation for CSL Area 21 (Dump and Fill Area - Abandoned Dump)

The site has now been classified. According to the decision tree (Fig. A-1), a detailed site characterization should now be performed. For testing purposes, this is impractical because on-site environmental work is only being simulated by the information in the report entitled, *Reassessment of Sierra Army Depot, Herlong, Calif., Report No 149R.* However, we will accept the limited contaminant information in the report and continue testing. Also, we will assume that remediation will be done, when in fact, it may not be necessary.

Continuing through the logic of Fig. A 1, we are directed to Appendix C. Here, we use Fig. C-1, *Procedure for Selection of Possible Treatments* and Table C-1, *Treatment Selection Table.* According to Fig. C-1 we are to assign a *Contaminant* code, a *Soil* code, and a *Contaminated Medium and Environment* code for each contaminant. The report stated that CSL Area 21 contains a wide variety of materials (including paint sludges, paint thinners, solvents, cleaning fluids and waste oil). Paint thinners, solvents, and cleaning fluids are VOC's, coded "V". Paint Sludges and waste oil are coded "O" for non-volatile organics. The soil is described in the report as sandy, which would be coded as "I". Also, the contaminated medium would be coded "Su". Therefore, the treatment identifier table, per Fig. C-1, would appear as:

	TREATMENT IDENTIFIER		
	1st field	2nd field	3rd field
Paint Thinner, Solvents and Cleaning Fluids	V	I	Su
Paint Sludges & Waste Oil	O	I	Su

After the process of deletion, as described in Fig. C-1, the LISTS OF TREATMENT NUMBERS look like:

Paint Thinner, Solvents and Cleaning Fluids

LIST OF TREATMENT NUMBERS		
V	V + I	V + I + Su
1	1	1
2		
3		
4	4	4
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25	25	25
27		
28		
29	29	29

Paint Sludges & Waste Oil

LIST OF TREATMENT NUMBERS		
O	O + I	O + I + Su
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
26		

Fortunately, Treatments 6 and 10 are common for all contaminants. Therefore, Steam Stripping (in situ) (**6**), and Soil Washing (in situ) (**10**), are recommended. The final choice would be determined by economics, available skills, available equipment, etc. The extracted and concentrated materials would then have to be disposed of, probably by incineration.

Bear in mind, that the Possible Treatments shown on Table C-1 are the currently demonstrated treatments at the time of publication. Other treatments are, and will be, in development.

METHODOLOGY TEST IV

CSL AREA 24 (LOWER BURNING/DEMOLITION GROUNDS)

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS

Determine (below) if Site Poses an Imminent Health Risk to Public

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
A1. Do Waste Constituents in Soil Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? *Factors* Very High Concentrations 15 Moderately High Concentrations 8 Low Concentrations 2	2	Pages 2-27 and 2-29 state that the contaminants are explosive compounds, liquid demilitarization wastes, and uncontrolled dumping wastes (including paint sludges, paint thinners, solvents, and degreasing sludges). However, page 2-28 states that 19 stations were sampled and tested for 6 explosive compounds and 8 metals with only low levels detected. Also EPA toxicity tests were conducted for 8 metals with only 2 samples exceeding EPA's threshold for arsenic. The area has been used for a burn-and-bury operation since 1946. Except for some hydrocarbons, metals, and unexploded munitions buried under 1 m of soil in a pit 2.4 m wide by 22.9 m long by 2.4 m deep, all wastes were burned.
A2. Do Waste Constituents in Ground Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? *Factors* Very High Concentrations 15 Moderately High Concentrations 8 Low Concentrations 2	2	There is no evidence that the constituents have reached the water table but the potential exists. Page 2-28 states that the water table is expected to be 10 to 30 m below the surface. The 2.4 m-deep pit invades the underlying bedded sand, silt, and clay, which has a high infiltration rate. The overlying soil has a low infiltration rate.
A3. Do Waste Constituents in Surface Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? *Factors* Very High Concentrations 20 Moderately High Concentrations 10 Low Concentrations 5	5	Page 2-29 states that there is low potential for surface contamination migration. This is because of (1) the arid climate and (2) the fact that most of the contaminants are under the soil overburden as opposed to on the top of the soil. The chances for erosion are quite small.
A4. Do Waste Constituents in Air Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? *Factors* Very High Concentrations 20 Moderately High Concentrations 10 Low Concentrations 5	5	Page 2-27 states that pits are backfilled. Page 2-29 states that there is low potential for surface water transport of contaminants.
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	**14**	**CONCLUSION: From this set of questions on imminent health risk to the public, the site ranks as a "Small Site".**

Determine (below) the Physical Setting of the Site

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
B1. Is Site in Close Proximity to Ground Water Supplies that are Used for Domestic or Agricultural Purposes? *Distance* — *Factors* 30 ft (9 m) or Less — 15 30 ft (9 m) to 100 ft (30 m) — 10 100 ft (30 m) to 300 ft (90 m) — 5 Greater than 300 ft (90 m) — 1	1	Pages 1-5 and 1-20 indicate that CSL Area 24 is approximately 12,000 m (39,000 ft) from the nearest wells, Wells 2, 5, and 6. The nearest agricultural area is at least 4,000 m from CSL Area 24.

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
B2. Is Site in Close Proximity to Surface Water Supplies that are Used for Domestic or Agricultural Purposes? Distance — Factors 300 ft (90 m) or Less — 15 300 ft (90 m) to 1000 ft (300 m) — 10 1000 ft (300 m) to 3000 ft (900 m) — 5 Greater than 3000 ft (900 m) — 1	1	Page 1-20 shows the location of the potable water sources for the SIAD, including the town of Herlong. These sources are four water well, Wells 2, 5, 8, and 9. No surface water is used for domestic purposes. The distance from CSL Area 24 to the nearest water well that is used for agricultural purposes is least 4,000 m upgradient.
B3. Is Waste in a Secure Containment(s)? Factors Uncontrolled — 15 Lined Diked Pit, Trench, or Pad — 8 In Sealed Containers — 2	15	Page 2-27 says that the contaminants resulted from a burn and bury operation on the ground and in pits.
B4. Is Access to Site Controlled? Factors Uncontrolled — 15 Limited Area with Fence — 8 Fenced and Guarded — 2	2	The site is on a military post that has guarded entries by the Military Police (Page 2-11).
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	19	**CONCLUSION: From this set of questions on physical setting, the site ranks as a "Small Site".**

Determine (below) If Site Is Subject to Rapid, Uncontrolled Releases to Biosphere

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
C1. Are Waste Forms Combustible? Factors Explosive or Spontaneous — 20 Moderate to High Combustibility — 15 Low Combustibility — 5 Noncombustible — 0	0	Although the report states that there are some unexploded munitions in the area (Page 2-28), the munitions are under at least 1 m of soil. This would mean no combustion. Exhumation might cause explosions.
C2. Is Waste Subject to Flooding? Factors High Probability — 15 Moderate Probability — 10 Low Probability — 5	5	Page 1-17 states that "The lack of surface drainage features in this area is a result of low precipitation, lack of topographic relief, and soil conditions."
C3. Is Waste Subject to Wind/Weather Damage or Dispersal (tornadoes, hurricanes, wind storms, lightning, etc.)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	2	Because the area is backfilled (page 2-27), there is no potential for airborne contamination migration.
C4. Is Waste Site Subject to Other Natural/Manmade Disasters or Disturbances that could Damage or Disperse Waste Forms (earthquakes, forest fires, artillery impacts, etc.)? Factors High Probability — 10 Moderate Probability — 5 Low Probability — 2	5	The greatest potential for such problems is associated with the explosives work, however, that is the purpose of this installation. The explosives activities are not spontaneous but rather are controlled.
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	12	**CONCLUSION: From this set of questions on rapid and uncontrolled releases to the biosphere, the site ranks as a "Small Site".**

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
Select Applicable Federal Laws and Regulations That Must be Complied With (see *Appendix B*)		
D1. Do Federal Regulations Require Early or Immediate Remedial Action? Factors Immediate Environ. Remediation 2.0 Immediate Interim Action 1.0 Eventual Environ. Remediation .5	.5	To our knowledge, no such regulations exist
D2. Can Site be Permanently Closed Without Remediation? Factors Yes 2.0 No 0	0	The site probably should be considered for remediation especially if and when SIAD is decommissioned
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	.5	CONCLUSION: **From this set of questions on applicable federal laws and regulations, the site ranks as a "Small Site".**
Determine (below) If Site Is a Major Societal or Political Issue		
E1. Are There Any Major Local (or Regional) Societal or Political Issues? Factors Considerable Press/Media Coverage 2.0 Some Press/Media Coverage 1.0 No Press/Media Coverage 0	0	Although the report does not address this, it is fairly safe to assume that there are no major societal or political issues. Most all the people in Herlong and the surrounding area, except those involved in agriculture, make their living either directly or indirectly at SIAD
E2. Is There Likelihood of Societal or Political Issues Before Scheduled Remediation? Factors Very High Probability .8 High Probability .6 Moderate Probability .4 Low Probability .3 Negligible Probability 0	0	Again, this is not addressed in the report, but for the same reason cited in Question E1 above, it is unlikely that any major societal or political issues will be raised
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	0	CONCLUSION: **From this set of questions on major societal or political issues, the site ranks as a "Small Site".**
Determine (below) the Estimated Costs to Remediate Site		
F1. What is Estimated Cost of Site Characterization? Factors Greater Than $1.5M 2.0 $1.0M to $1.5M 1.4 $.5M to $1.0M .7 Less Than $.5M 0	0	Most of the site characterization has already been done

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
F 2. What is Estimated Cost of Waste Treatment? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	0	The responsible people at SIAD probably already feel that the pits have been remediated when they were backfilled. The surface area soil may have to be removed and incinerated.
F 3. What is Estimated Cost of Site Closure & Monitoring? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	7	Assuming the site has been remediated as shown in Question F2 the cost of closure would be very minimal but site monitoring would be required because of the unexploded munitions.
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	7	**CONCLUSION: From this set of questions on estimated costs for remediation, the site ranks as a "Small Site".**

FINAL CONCLUSION: *Because none of the previous* conclusions on this site, CSL Area 24, concluded otherwise, this site is ranked as a "Small Site". This is considered to be the "First Iteration thru the Logic" (see Fig A-1 at the entry point to the Site Remediation section). According to the logic of the "Waste Site Classifier", a detailed site characterization (RI/FS) should be conducted. At the conclusion of the detailed site characterization, a second iteration should be made through the logic above to see if the classification changes. (See "Conclusions on Testing of Waste Site Classifier" for more information on this site ranking.)

RANKING AGAINST OTHER SITES: For purposes of ranking this site against the other sites being tested, this site has a total ranking of 57. That is,

A1 thru A4	=	**14**
B1 thru B4	=	**19**
C1 thru C4	=	**12**
D1 thru D2	=	**5**
E1 thru E2	=	**0**
F1 thru F3	=	**7**
		57

Site Remediation for CSL Area 24 (Lower Burning/Demolition Grounds)

The site has now been classified. According to the decision tree (Fig. A-1), a detailed site characterization should now be performed. For testing purposes, this is impractical because on-site environmental work is only being simulated by the information in the report entitled, *Reassessment of Sierra Army Depot, Herlong, Calif., Report No 149R.* However, we will accept the limited contaminant information in the report and continue testing. Also, we will assume that remediation will be done when in fact, it may not be necessary.

Continuing through the logic of Fig. A-1, we are directed to Appendix C. Here, we use Fig. C-1, *Procedure for Selection of Possible Treatments* and Table C-1, *Treatment Selection Table.* According to Fig. C-1 we are to assign a *Contaminant* code, a *Soil* code, and a *Contaminated Medium and Environment* code for each contaminant. The report stated that CSL Area 24 contains explosive compounds, liquid demilitarization wastes, and uncontrolled dumping wastes (including paint sludges, paint thinners, solvents, and degreasing sludges). Except for some hydrocarbons, a small amount of metals, and unexploded buried munitions, all wastes were burned. The buried unexploded munitions are explosives, coded "X". Paint thinners and solvents are VOC's, coded "V". Paint sludges and degreasing sludges are coded "O" for non-volatile organics. Because the metals and granulated explosive compounds (not buried unexploded munitions) were so low they will be ignored (see Page 2-28). The soil is described in the report as sandy, which would be coded as "I". Also, the contaminated medium would be coded "Su". Therefore, the treatment identifier table, per Fig. C-1, would appear as:

	TREATMENT IDENTIFIER		
	1st field	2nd field	3rd field
Buried Unexploded Munitions	X	I	Su
Paint Thinners & Solvents	V	I	Su
Paint Sludges & Degreasing Sludges	O	I	Su

After the process of deletion, as described in Fig. C-1, the LISTS OF TREATMENT NUMBERS look like:

Buried Unexploded Munitions

LIST OF TREATMENT NUMBERS		
X	X + I	X + I + Su
8		
9		
10	10	10
13		
16		
17		
18		
19		
20		
21		
26		
28		
29	29	29

Paint Thinners & Solvents

LIST OF TREATMENT NUMBERS		
V	V + I	V + I + Su
1	1	1
2		
3		
4	4	4
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25	25	25
27		
28		
29	29	29

Paint Sludges & Degreasing Sludges

LIST OF TREATMENT NUMBERS		
O	O + I	O + I + Su
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
26		

Treatment 10 is common for all contaminants. Therefore, Soil Washing (in situ) (**10**), is recommended. However, the report did say that the buried munitions were unexploded. This means they are large in volume and a long time may be required to soil wash the munitions out. It might be wise to conduct a two step remediation. The first step could be Aerobic Biodegradation (in situ) (**29**) to address the munitions. The second step could be Soil Washing (in situ) (**10**). The extracted and concentrated materials would then have to be disposed of, probably by incineration.

Bear in mind, that the Possible Treatments shown on Table C-1 are the currently demonstrated treatments at the time of publication. Other treatments are, and will be, in development.

METHODOLOGY TEST V

DPDO TRENCHES (UNDESIGNATED BY CSL)

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
Determine (below) if Site Poses an Imminent Health Risk to Public		
A 1. Do Waste Constituents in Soil Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? Factors Very High Concentrations 15 Moderately High Concentrations 8 Low Concentrations 2	8	Pages 2-29 and 2-30 state that the contaminants are waste oils oil sludges. solvents, cleaning fluids, and ash residue from burning of wood, paper, and waste oils and sludges The area was used for a burn-and-bury operation between 1942 and 1973
A 2. Do Waste Constituents in Ground Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? Factors Very High Concentrations 15 Moderately High Concentrations 8 Low Concentrations 2	2	There is no evidence that the constituents have reached the water table but the potential exists Page 2-30 states that the water table is expected to be 40 m below the surface The overlying and underlying soils are sandy and have a high infiltration rate
A 3. Do Waste Constituents in Surface Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? Factors Very High Concentrations 20 Moderately High Concentrations 10 Low Concentrations 5	5	Although the report says nothing about surface water for this area, it is approximately 2000 m from CSL Area 20 Page 2-26 states that CSL Area 20 has no potential for surface contamination migration. The chances for erosion are quite small
A 4. Do Waste Constituents in Air Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk? Factors Very High Concentrations 20 Moderately High Concentrations 10 Low Concentrations 5	5	Page 2-29 states that one trench is backfilled and the second is open but inactive The waste material that was placed in the trenches was either burned or absorbed into the soil Thus the chances of air borne migration of contaminants is small
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	20	**CONCLUSION: From this set of questions on imminent health risk to the public, the site does not rank as a "Small Site".**
Determine (below) the Physical Setting of the Site		
B 1. Is Site in Close Proximity to Ground Water Supplies that are Used for Domestic or Agricultural Purposes? Distance / Factors 30 ft (9 m) or Less 15 30 ft (9 m) to 100 ft (30 m) 10 100 ft (30 m) to 300 ft (90 m) 5 Greater than 300 ft (90 m) 1	1	Pages 1-20 and E-2 indicate that the DPDO Trenches are approximately 1200 m (3900 ft) from the nearest wells Wells 2 and 8 The nearest agricultural area is at least 12 000 m from *the DPDO Trenches*

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
B2. Is Site in Close Proximity to Surface Water Supplies that are Used for Domestic or Agricultural Purposes?	1	Page 1-20 shows the location of the potable water sources for the SIAD, including the town of Herlong These sources are four water well, Wells 2, 5, 8, and 9 No surface water is used for domestic purposes The distance from the DPDO Trenches to the nearest water well that is used for agricultural purposes is least 12,000 m upgradient

Distance	Factors
300 ft (90 m) or Less	15
300 ft (90 m) to 1000 ft (300 m)	10
1000 ft (300 m) to 3000 ft (900 m)	5
Greater than 3000 ft (900 m)	1

B3. Is Waste in a Secure Containment(s)?	15	Pages 2-29 and 2-30 say that the contaminants resulted from a burn-and-bury operation in pits and pouring of liquid contaminants into the pits

	Factors
Uncontrolled	15
Lined/Diked Pit, Trench, or Pad	8
In Sealed Containers	2

B4. Is Access to Site Controlled?	2	The site is on a military post that has guarded entries by the Military Police (Page 2-11)

	Factors
Uncontrolled	15
Limited Area with Fence	8
Fenced and Guarded	2

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	19	**CONCLUSION: From this set of questions on physical setting, the site ranks as a "Small Site".**

Determine (below) if Site is Subject to Rapid, Uncontrolled Releases to Biosphere

C1. Are Waste Forms Combustible?	0	Pages 2-29 states that one trench is covered, which means no combustion is possible. The other trench is open but not active. Because this was a burn-and-bury operation, it is assumed that burning took place but not necessarily burying. However, all the remaining hydrocarbons must be within the soil and not on top of the soil after 10 years. This would mean no combustion

	Factors
Explosive or Spontaneous	20
Moderate to High Combustibility	15
Low Combustibility	5
Noncombustible	0

C2. Is Waste Subject to Flooding?	5	Page 1-17 states that "The lack of surface drainage features in this area is a result of low precipitation, lack of topographic relief, and soil conditions."

	Factors
High Probability	15
Moderate Probability	10
Low Probability	5

C3. Is Waste Subject to Wind/Weather Damage or Dispersal (tornadoes, hurricanes, wind storms, lightning, etc.)?	5	Because one trench is backfilled (page 2-29), there is no potential for airborne contamination migration. The other trench is open but inactive. If there were any contaminants, such as unburied ash residue, it probably would have been widely dispersed across the landscape over the 10-year period between when the trench was deactivated and the time of the report writing

	Factors
High Probability	10
Moderate Probability	5
Low Probability	2

C4. Is Waste Site Subject to Other Natural/Manmade Disasters or Disturbances that could Damage or Disperse Waste Forms (earthquakes, forest fires, artillery impacts, etc.)?	5	The greatest potential for such problems is associated with the explosives work, however, that is the purpose of this installation. The explosives activities are not spontaneous but rather are controlled

	Factors
High Probability	10
Moderate Probability	5
Low Probability	2

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	15	**CONCLUSION: From this set of questions on rapid and uncontrolled releases to the biosphere, the site ranks as a "Small Site".**

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS

Select Applicable Federal Laws and Regulations That Must be Complied With (see *Appendix B*)

D1. Do Federal Regulations Require Early or Immediate Remedial Action?	5	To our knowledge, no such regulations exist

	Factors
Immediate Environ. Remediation	20
Immediate Interim Action	10
Eventual Environ. Remediation	5

D2. Can Site be Permanently Closed Without Remediation?	0	The site probably should be considered for remediation, especially if and when SIAD is decommissioned

	Factors
Yes	20
No	0

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	5	**CONCLUSION: From this set of questions on applicable federal laws and regulations, the site ranks as a "Small Site".**

Determine (below) If Site is a Major Societal or Political Issue

E1. Are There Any Major Local (or Regional) Societal or Political Issues?	0	Although the report does not address this, it is fairly safe to assume that there are no major societal or political issues. Most all the people in Herlong and the surrounding area, except those involved in agriculture, make their living either directly or indirectly at SIAD.

	Factors
Considerable Press/Media Coverage	20
Some Press/Media Coverage	10
No Press/Media Coverage	0

E2. Is There Likelihood of Societal or Political Issues Before Scheduled Remediation?	0	Again, this is not addressed in the report, but for the same reason cited in Question E1 above, it is unlikely that any major societal or political issues will be raised

	Factors
Very High Probability	8
High Probability	6
Moderate Probability	4
Low Probability	3
Negligible Probability	0

TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	0	**CONCLUSION: From this set of questions on major societal or political issues, the site ranks as a "Small Site".**

Determine (below) the Estimated Costs to Remediate Site

F1. What is Estimated Cost of Site Characterization?	0	The sizes and locations of the trenches are known. However, the extent of hydrocarbon migration from the DPDO Trenches to the ground water is not known. The cost of determining this is not too great

	Factors
Greater Than $1.5M	20
$1.0M to $1.5M	14
$.5M to $1.0M	7
Less Than $.5M	0

QUESTIONS AND WEIGHTING FACTORS	ASSIGNED WEIGHTING FACTOR	COMMENTS
F2. What is Estimated Cost of Waste Treatment? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	7	The open but inactive trench should be backfilled. It is possible that caps should be installed over both trenches.
F3. What is Estimated Cost of Site Closure & Monitoring? Factors Greater Than $1.5M — 20 $1.0M to $1.5M — 14 $.5M to $1.0M — 7 Less Than $.5M — 0	7	Assuming the site has been remediated as shown in Question F2, the cost of closure would not be great but site monitoring would be required.
TOTAL ASSIGNED WEIGHTING FACTOR FOR THIS SECTION	14	**CONCLUSION: From this set of questions on estimated costs for remediation, the site ranks as a "Small Site".**

FINAL CONCLUSION: Because Section A [Determine (below) If Site Poses an Imminent Health Risk to Public] scored 20 points, this site, the DPDO Trenches, is not ranked as a "Small Site". This is considered to be the "First Iteration thru the Logic" (see Fig A-1 at the entry point to the Site Remediation section). According to the logic of the "Waste Site Classifier", a detailed site characterization (RI/FS) should be conducted. At the conclusion of the detailed site characterization, a second iteration should be made through the logic above to see if the classification changes. (See "Conclusions on Testing of Waste Site Classifier" for more information on this site ranking.)

RANKING AGAINST OTHER SITES: For purposes of ranking this site against the other sites being tested, this site has a total ranking of 73. That is,

A1 thru A4	=	20
B1 thru B4	=	19
C1 thru C4	=	15
D1 thru D2	=	5
E1 thru E2	=	0
F1 thru F3	=	14
		73

Site Remediation for DPDO TRENCHES (Undesignated by CSL)

The site has now been classified. According to the decision tree (Fig. A-1), a detailed site characterization should now be performed. For testing purposes, this is impractical because on-site environmental work is only being simulated by the information in the report entitled, *Reassessment of Sierra Army Depot, Herlong, Calif., Report No 149R*. However, we will accept the limited contaminant information in the report and continue testing. Also, we will assume that remediation will be done, when in fact, it may not be necessary.

Continuing through the logic of Fig. A-1, we are directed to Appendix C. Here, we use Fig. C-1, *Procedure for Selection of Possible Treatments* and Table C-1, *Treatment Selection Table*. According to Fig. C-1 we are to assign a *Contaminant* code, a *Soil* code, and a *Contaminated Medium and Environment* code for each contaminant. The report stated that DPDO Trenches contain waste oils, oil sludges, solvents, cleaning fluids, and ash residue from burning of wood, paper, and waste oils and sludges. The waste oils, oil sludges, and ash are non-volatile organics, coded "O". The solvents and cleaning fluids are VOC's, coded "V". The soil is described in the report as sandy, which would be coded as "I". Also, the contaminated medium would be coded "Su". Therefore, the treatment identifier table, per Fig. C-1, would appear as:

	TREATMENT IDENTIFIER		
	1st field	2nd field	3rd field
Waste Oils, Oil Sludges, & Ash	O	I	Su
Solvents & Cleaning Fluids	V	I	Su

After the process of deletion, as described in Fig. C-1, the LISTS OF TREATMENT NUMBERS look like:

Waste Oils, Oil Sludges, & Ash

LIST OF TREATMENT NUMBERS		
O	O + I	O + I + Su
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
26		

Solvents & Cleaning Fluids

LIST OF TREATMENT NUMBERS		
V	V + I	V + I + Su
1	1	1
2		
3		
4	4	4
5		
6	6	6
7		
8		
9		
10	10	10
12		
13		
14		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25	25	25
27		
28		
29	29	29

Fortunately, Treatments 6 and 10 are common for all three contaminants. Therefore, Steam Stripping (in situ) (**6**), and Soil Washing (in situ) (**10**), are recommended. The final choice would be determined by economics, available skills, available equipment, etc. The extracted and concentrated materials would then have to be disposed of, probably by incineration.

Bear in mind, that the Possible Treatments shown on Table C-1 are the currently demonstrated treatments at the time of publication. Other treatments are, and will be, in development.

CONCLUSIONS

While the results of the five tested sites appear to demonstrate the waste site analyzer, we feel that this number of sites is not statistically significant. To perfect the methodology will require a more extensive testing phase involving multiple sites and multiple users testing the same sites

The five SIAD sites that were used to test the waste site analyzer are more properly known as Small Waste Management Units (SWMUs) on one site, the SIAD. The results of answering some questions were the same for all SWMUs. As an example, the answers to questions about weather and local political issues were the same for all SWMUs.

The following illustration, entitled COMPARATIVE RANKING OF FIVE SIAD SITES, summarizes the results of testing of five SIAD sites.

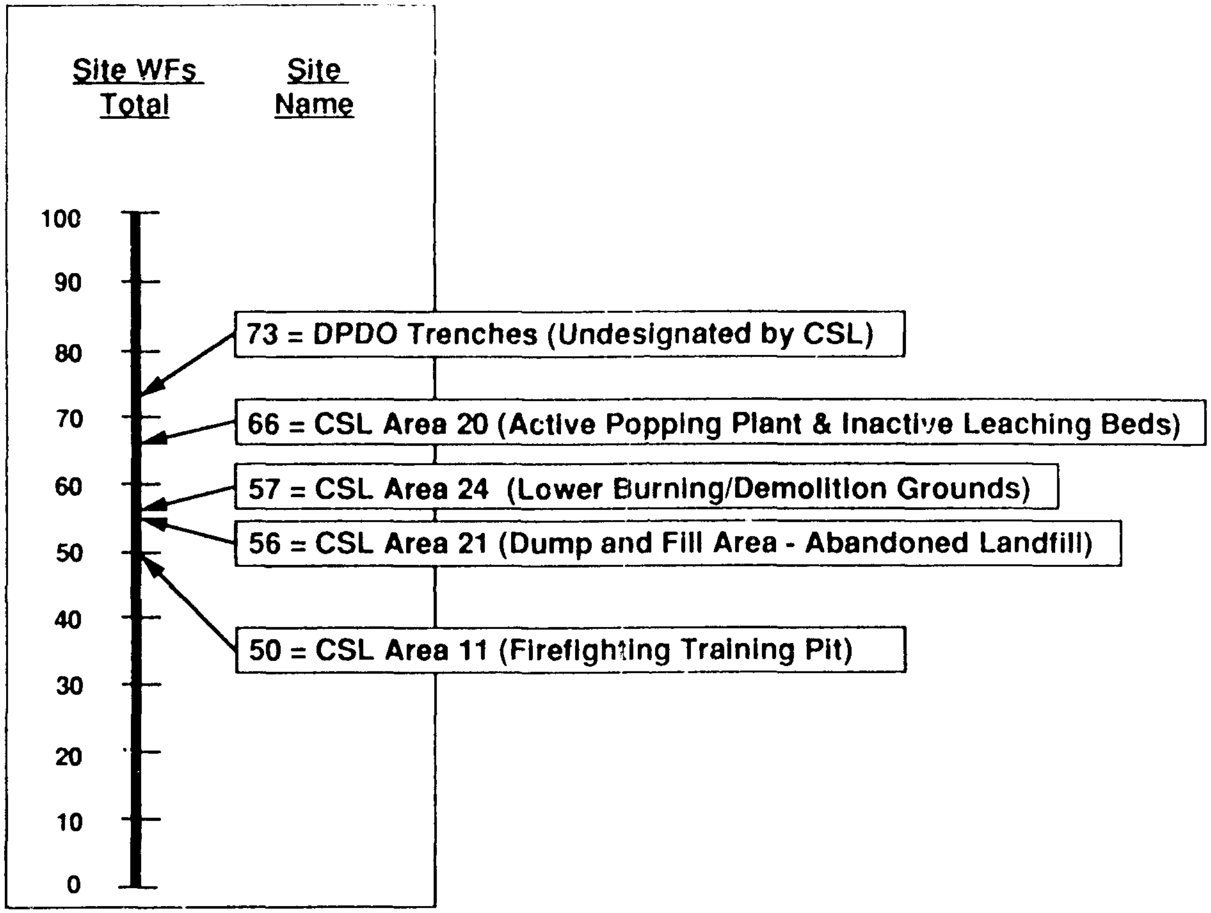
During the testing the following difficulties were encountered:

1. The lowest weighting factor is too high for Question A3, "Do Waste Constituents in Surface Water Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?". The same thing is true for Question A4, "Do Waste Constituents in Air Contain Sufficient Quantities of Toxic Organics or Heavy Metals to be a Health Risk?"

   As an example, in cases of *no surface water problems* and *no air problems*, the weighting factors result in a mandatory score of 10, which is already half of that value required to exceed a "Small Site" rating. This means that a buried waste site in an arid climate has to have a minimum score of 10 for Questions A3 and A4 combined. CSL Area 21 and the DPDO Trenches are such examples. Both did not rank as "Small Sites" when they probably should have, according to Questions A1 through A4.

2. Question B3, "Is Waste in a Secure Containment(s)?", might lead to overclassification of a site. The weighting factor of 15 for "Uncontrolled" is already three quarters of the way to exceeding the "Small Site" rating. Quantity of waste is not considered. Example: Five gallons of paint thinner poured on the ground results in 15 points.

3. Question D2, "Can Site be Permanently Closed Without Remediation?", can be misleading. Its original intent was to force the investigator to conduct some form of site characterization, rather than stay in his/her office and assume that there is no problem. We wanted the investigator to at least go look at the site. However, if all evidence indicates that there is no problem with a site and the question is answered "Yes", it automatically is kicked out of the "Small Site" class.



COMPARATIVE RANKING OF FIVE SIAD SITES

7/18/90
DAY.PLA1.WM

4. The primary discriminator entitled, "Federal Laws and Regulations", is exceedingly difficult to address. Therefore, only two questions (D1 and D2) were asked in an effort to capture the bottom-line conclusions of an otherwise separate, extensive legal search.

RECOMMENDATIONS

The decision tree, Fig. A-1, should probably be modified to include a question about permeability of the soil in/on which the waste lies. Likewise, a question should probably be asked about the approximate quantity of waste involved.

It is recommended that additional testing of the waste site analyzer be conducted. The weighting factors and the threshold limits for each primary discriminator (20) can be modified based upon experience. The testing should involve a statistically significant number of sites and testers. Each site should be tested by more than one tester and their results averaged to make a final decision on the site. A final decision of any one site should never be made by just one tester, even after the waste site analyzer has been perfected.

In the final computerized version of the analyzer, the numerical value of each weighting factor should be masked from the user. Only the possible alphabetic answers should be made available on the user's computer screen. The translation of alphabetic answers to weighting factor numbers would be made by an uninterested person (or computer) probably located at THAMA in Aberdeen, MD. Using this approach, it would be a little more difficult for the users to deliberately force the outcome.

The problem of "which regulations are applicable" is a near insurmountable problem. There are multiple regulating organizations promulgating both redundant and contradictory sets of rules. The waste site owner cannot satisfy all the regulators and regulations no matter how hard he/she tries. Therefore, until this situation is corrected by legislation, the waste site owner needs guidance and, yes, protection. Currently, the only sources for guidance and protection are environmental consulting companies and lawyers (corporate and private). Many waste site owners cannot afford these. There is a possible answer to this dilemma, that is, an artificial intelligence (expert) system for use by the waste site owners. Such a system, if and when developed, would have wide application. The system would have all the rules and regulations that are currently written into the competing laws. The knowledge and experience of "experts" in environmental science and law would also be included. The user of the expert system would not have to be an environmental scientist, a computer scientist, or a lawyer. The system cannot change the laws but it could (1) provide useful guidance, (2) warn the user of potential problems ahead, and (3) provide information on court decisions and new legislative actions.

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